Bind

SCIENTIFIC AMERICAN SUPPLEMENT. No. 1892

Entered at the Post Office of New York, N. Y., as Second Class Matter.
Copyright, 1912, by Munn & Co., Inc.

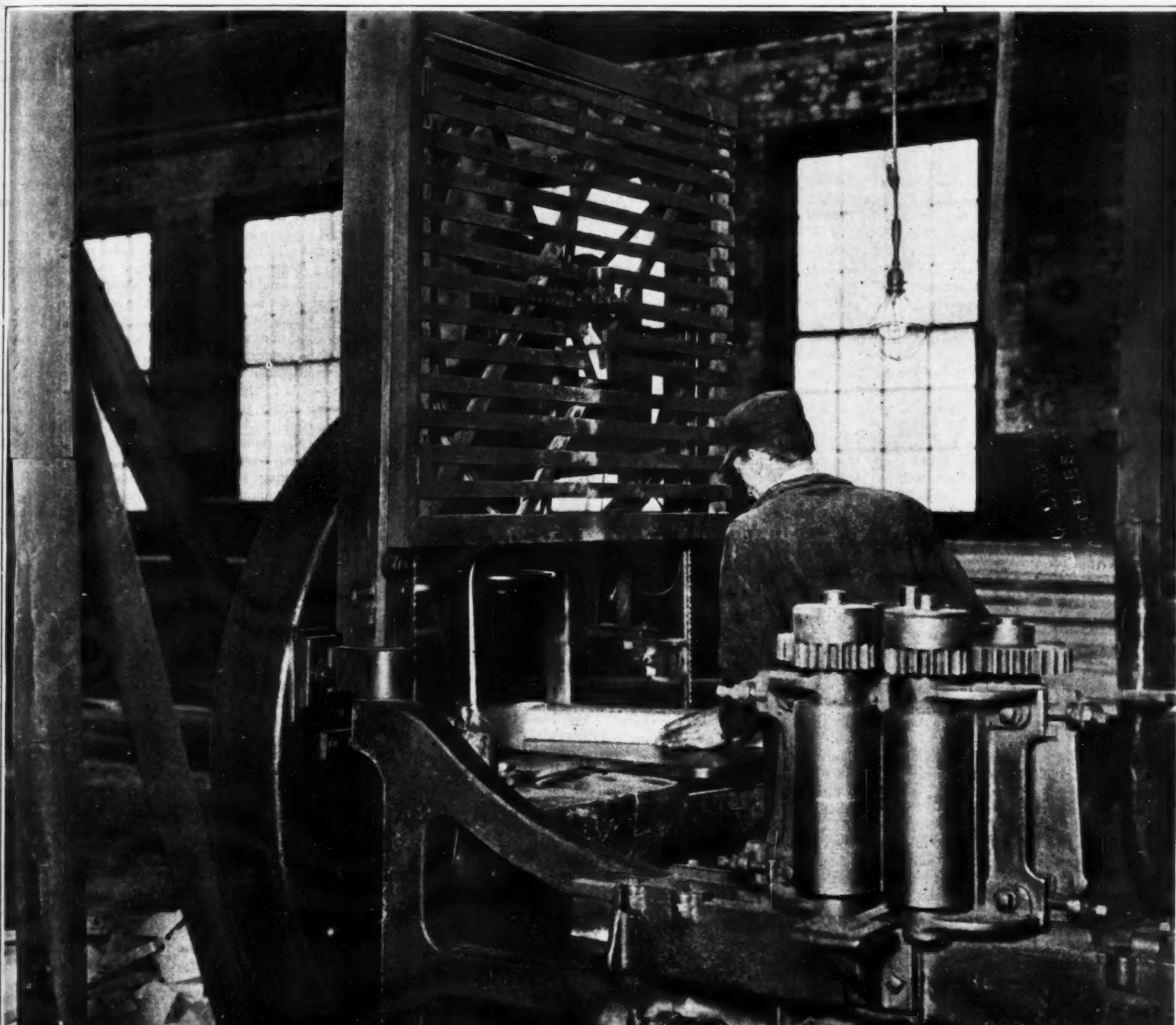
Published weekly by Munn & Co., Inc., at 361 Broadway, New York.

Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXXIII., No. 1892.

NEW YORK, APRIL 6, 1912.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



Band Saw With Protecting Trellis Work

INDUSTRIAL ACCIDENTS AND THEIR PREVENTION.—[See page 216.]

Preserving Good Roads*

The Utilization of Motor-Truck Trains in the Maintenance of Trunk Highways

By Logan Waller Page, Director, Office of Public Roads, United States Department of Agriculture

During the road-building season just drawing to a close, about $142,000,000 were expended in this country on road construction. A considerable portion of this money was raised by bond issues. In most of the communities where bonds were issued, practically no serious thought has been given to maintenance of the roads after they are constructed. In other words, thirty or forty year bonds were issued for five year roads. It is impossible for this condition to obtain for any considerable length of time, for we can not continue to borrow money for the construction of roads and let them go to ruin. It is necessary for us to turn our attention more to the maintenance problems than to those of construction, for the former are far more complicated under the present condition of traffic. As far as I have been able to ascertain, practically no data on maintenance exists in this country. A few of the State highway commissions are inaugurating plans for maintenance, and also a very few counties, but aside from this, almost nothing has been done.

The cost of maintenance for the National roads of France has been more or less our guide for many years, but my observations lead me to believe that the French roads to-day are not being maintained as they should be. This I believe is due to two causes, one that a sufficient amount of money per mile per year is not being expended, and the other is that I do not consider under present traffic conditions that the canton system of road maintenance is effective.

The British system of maintenance can hardly be called a system, but, judging from the results obtained, I think it is more thorough, and gives better results than the French. It must be remembered, however, that the British maintenance costs almost twice as much as the French.

I have been considering the maintenance problem under American conditions for some years, and it is my belief that the canton or patrol system will not meet the conditions that obtain on a bituminous macadam road. When such a road is properly constructed, for at least a year and a half there is almost nothing for the patrolman to do but walk over it. When trouble comes, it is generally due to the disintegration of the binder, bringing about loose spots on the surface. For a patrolman to repair such trouble is expensive, for a tar kettle, stone, and small tools are necessary. Such work can be done better and more quickly with a small gang of men, and if a quickly moving vehicle to carry the equipment and men is obtainable, a considerable length of road can be repaired in a very short time. On roads that have a bituminous blanket coat treatment, this method of maintenance is even more applicable than on roads built by the penetration or mixing method.

With this idea of maintenance in mind, some months ago the Office of Public Roads engaged the services of one of the ablest motor truck designers in the United States for the purpose of designing a motor maintenance car or train, the thought being that we might "cure the bite with the hair of the dog." The instructions given to this designer were that the train or motor truck should have the capacity for maintaining at least one hundred miles of bituminous macadam road, and should have the necessary equipment to apply blanket coat treatments. The result of this investigation was as follows:

The object to be accomplished is the development of an automobile equipment which will include all the apparatus and facilities necessary to efficiently employ a repair gang of eight men in the maintenance of road surface over one hundred miles of roadway or more as the working conditions will permit.

This equipment is to be capable of making quick transport of men and their necessary working outfit between a central base or headquarters and the various places along the roadway where repairs may be necessary; the equipment to carry, as well as men and apparatus, enough road repair material for a number of quick repairs in isolated places, when these are not very extensive. Where extensive repairs are necessary and require considerable material, the equipment is to be flexible enough to provide for rapid conveyance of stone or other material from a distant supply station to the place of operation.

The purpose of developing such an equipment is to provide an actual working outfit as a practical exemplary inducement to state highway commissions and others charged with road maintenance to procure and use similar outfits; thereby effecting a much greater efficiency and economy than can be accomplished with existing methods and insuring the collateral advantage of a better condition of road surface, in view of the facility with which timely repairs can be made.

This purpose as set forth has three significant implications: First, that the cost of the equipment should be kept consistently low or within the range of customary expenditures in this direction; second, novel or especially manufactured apparatus should be avoided so that equivalent apparatus can be secured in any locality, and further, that existing investment in similar details of equipment can be made use of; third, that the outfit should be so flexible in its makeup as to readily serve a variety of purposes or lend itself to peculiar requirements under varying conditions.

These considerations necessarily prohibit the employment of any cumbersome or expensive tractor trains and rather demand a single machine with ability to handle a single trailer where such may be required. This machine should be capable of performing all the useful transporting functions required in road repairs, in addition to being serviceable for maintenance work, such as the distribution or sprinkling of road oils or bituminous material, and, furthermore, should be available during the winter season for general trucking purposes, such as snow and refuse removal or other hauling service.

In performing service in road repairing, the machine should incorporate as many of the requirements of a portable power plant as possible, such as hoisting, pumping, and where necessary, air compression and power shaft driving. It should have considerable traction ability, and be operable at a reasonable speed when loaded, as at a higher speed for empty return trip or emergencies.

To secure the required combination in such an outfit the entire supply of available equipment on the market has been investigated and carefully considered.

The automobile chassis selected for recommendation is the 5-ton gas-electric type manufactured by the Couple-Gear Freight Wheel Company, Grand Rapids, Michigan. This is well developed and has been in varied and rigorous service for a number of years. Its availability and service capacity is vouched for by a number of merchant users and its flexibility is well shown in the United States War Department, Engineer Department at Large, Professional Memoirs, Volume 3, No. 9.

The advantage in this line of work of a traction drive at each of the four wheels will be appreciated and the range of application of the power of the machine in auxiliary apparatus by its conversion into electric current is self evident.

The chassis, in addition to its regular equipment, is fitted with a Sprague electric hoist, the purpose of which is to aid in loading and unloading the body and other apparatus which the machine carries (to be described later), as well as for general hoisting external to the machine whenever required. The electric motor of this hoist is directly connected to a rotary pump which is used to force the road oil or bituminous material from a tank, carried on the machine, through a distributing device permanently attached to the rear of the chassis. This electric hoist and rotary pump are located forward of and about one-fourth the distance from the rear to the forward wheels, below the floor of the body which rests on the chassis. The pump and distributor recommended for permanent attachment to the chassis by the automobile engineer are a part of the horse-power spreader built by the A. Burlingame Company of Worcester, Massachusetts.

This chassis can be fitted with a removable platform body of any convenient or desirable dimensions with or without stakes or side racks when the machine is used for hauling purposes in those seasons of the year when road work is not feasible.

The chassis may also be fitted with a steel dumping body, length 130 inches, height 36 inches, bottom width 56 inches, and top width 78 inches. The forward half of this body should have two removable partitions, so placed that one cubic yard of material can be carried in the forward space and two cubic yards of material in the rear space.

Each of these two spaces should have vertical sliding side doors, operated by hand levers to allow material to be unloaded from the floor of the body rather than over the sides. The purpose of these removable partitions is to provide for carrying a variety of road material, or to carry a limited amount and to permit the balance of the body being used for other purposes. This body should be so located on the chassis as to leave sufficient space behind the driver's seat and in front of the dumping body for carrying tools and men. The body should be entirely removable when the machine is required for a platform wagon. In operation for road work, this steel body can be dumped either by hand-winches, or by a proper arrangement of pulleys, the electric hoist may be used for this purpose. The mounting on, or removing of, this dumping body from the chassis would be accomplished by the use of the electric hoist.

The next essential part of the equipment is a tar heating kettle of sufficient capacity to be serviceable on the roadside for repair work or to serve the purpose of a distributing tank wagon when carried on the machine.

For this purpose, a 500-gallon kettle, mounted on wheels and of such dimensions that it will occupy all of the dumping body but the forward one yard compartment referred to, is recommended. About the only change necessary to adapt any of the standard tar heating kettles to this purpose would be the shortening of the rear axle. The tar kettle may be loaded and unloaded by means of the power winch.

On either side of the tool-carrying compartment immediately in front of the dumping body there should be seats provided on each side for two men. The driver's seat will also be wide enough to carry four men, so that eight men in all may be transported. It is also presumed that the foreman of the gang will operate the machine.

With the equipment described, it will be quite possible to do isolated patch work over a long stretch in caravan fashion without dismounting any of the apparatus. In such service, the small stone compartment may be replenished at stone supply stations along the route, and if these do not exist and it becomes desirable to carry on the machine a larger working supply from the original base, the tar kettle could be projected outward some distance at the rear of the body so as to use the forward half of the body for stone, but it would be preferable under such working conditions to use a tar kettle of smaller capacity.

It may be suggested here that a feasible means toward operating in transit as described would be to provide at various points in the system of roads to be cared for, a number of supply stations where stone and bituminous materials could be kept on hand. These stations could be periodically replenished by the machine under consideration.

When working under normal roadside conditions, where a large amount of work is to be done, the machine would proceed from headquarters loaded, to the place of operation, where the tools and preliminary stone supply would be removed and the tar kettle unloaded. This would leave the machine free to be used immediately for the transfer of stone in quantity from the nearest base of supply.

In the event of work being so far from the stone supply base as to keep the gang inactive during the return trips of the machine, a trailer could be used to furnish a larger initial supply and transport a greater quantity for each of the subsequent trips. It might also be used to make the outfit and initial supply complete for extremely isolated or outpost work.

To use the machine as a sprinkler of road oils or a spreader of bituminous material, the tar kettle is loaded in the steel body and by means of a pipe connection at the back of the machine, the rotary pump is supplied with the liquid material from the kettle, which it forces through the spreader, for which use a removable rear seat is provided. In long trips away from the supply of oil or bituminous material, an additional supply in barrels may be carried in the forward part of the machine.

To get the required heat for bitumens, the firebox of the tar kettle can be fitted with a removable gasolene or kerosene burner. If gasolene is used as a fuel, the regular tank on the car can be made to furnish the supply. If kerosene is used, an auxiliary tank can be located on the chassis frame, and the necessary pressure in either case furnished by the exhaust from the engine. The feature of having this burner removable admits of the use of wood in the firebox for roadside work.

Should the employment of the tar kettle as above described be considered inadequate in the matter of capacity, a complete tank equipment could be provided and placed on the chassis when required for this service.

In the event of compressed air being desirable for any part of the work, the machine can be fitted with an electric air compressing outfit.

In selecting a pressure type of distributor, consideration is given to the speed at which the machine may be made to work. If this is not required, there are several cheaper forms of gravity devices on the market which may be applied.

An approximate estimate of the total equipment suggested above is as follows:

Machine with steel dumping body	$6,000.00
Sprague Electric Hoist	250.00
Horse-power Spreader, with rotary pump and piping	700.00
Tar kettle, 500 gallons capacity	300.00
Double kerosene burner outfit	200.00
Tools and accessories	50.00
	$7,500.00

* Paper read before Section D of the American Association for the Advancement of Science.

The Musical Memory and Its Derangements*

Peculiar Afflictions to Which Musicians Are Occasionally Subject

It is a somewhat remarkable thing that we all possess many faculties of whose mode of working we may remain almost entirely ignorant. Indeed, in some cases, we do not even suspect their existence until it is pointed out to us by those who have made a study of such things. An example of this kind is the sense of equilibrium. Few persons who have not had this brought to their attention in a course in biology would suspect its existence, still less form any idea of the anatomical features on which its mechanism depends, namely, certain canals in the internal ear.

The situation is not quite so extreme in the case of some other senses. Thus for instance, we are all fully aware of our faculties of speech and musical appreciation and yet very few persons would, of their own observation, become cognizant of some of the details of the mental mechanism involved in the process of speaking or understanding speech, or appreciating music or producing it. The fact is that even the trained observer would probably have overlooked many of the facts bearing on these matters, but for the light which is so often shed on the normal process by some abnormal and unusual condition. It would perhaps hardly have occurred to anyone that the understanding of spoken words involves a mental process and certain cells of the brain entirely distinct and independent of those playing part in the mere hearing of sound. And yet this becomes very clear in the case of certain abnormal conditions when, through either disease or injury, the particular portion of the brain concerned fails to properly do its duty. In such cases some very extraordinary conditions may arise. Thus, a person, while preserving his hearing perfectly intact, may be utterly unable to understand words spoken to him, although the sound reaches his ear and is plainly heard by him—as a mere noise. Such a person may otherwise be in full possession of his mental faculties. He may or may not be able to speak intelligently. This condition is what is technically termed sensory aphasia. In other cases, he may lose his power of speech; that is to say, of forming words, although his vocal organs are in a perfectly sound condition, and yet he may be able to understand what is said to him. He may still be able to repeat a word that is spoken to him, but is unable to formulate speech without such assistance. This condition is known as motor aphasia, or, more precisely, referring to the inability to utter words, aphemia; if a person has lost his ability to write words the condition is termed agraphia. Accompanying such a condition or apart from it may occur a similar derangement in which the patient suddenly loses his faculty of reading. He becomes "word blind," as the saying is, or suffers from alexia. These facts are now well known to the medical profession.

Somewhat less familiar are corresponding states which affect the musical faculties. To understand the situation it is necessary for us to endeavor to clear up our ideas as to the normal operations involved in the exercise of musical skill, in particular as regards the rendition of memorized pieces. Such memorizing evidently comprises the following steps: first, the reception of the musical strain, either by hearing or from the printed score; secondly, the memorizing of this—a step which may be performed in a variety of ways and which always involves to some extent several distinct faculties. The third step relates to the physical processes by which the music is rendered, that is to say, reproduced audibly as physical sound.

The particular method adopted by different individuals varies from case to case. In some, memory is chiefly of the auditory type, that is to say, the individual remembers the sound of the thing committed to memory. In other cases the motor element of the memory predominates, or in other words, the person retains a recollection of the movement of the fingers, for example, in piano playing; and thirdly, some individuals have a strongly developed visual memory, and can recall the actual image of the printed score before their mind's eye. Obviously, any psychological derangements which may occur would be liable to affect any one or more of the faculties thus involved, and according to the particular point attacked the results will differ.

The condition of amusia, as it is called, in general displays characteristics similar to those described above with regard to aphasia, that is to say, we can distinguish a motor and a sensory type of amusia. Dr. J. Leonard Corning, in a paper on Amusia, of which this article represents a somewhat detailed review, quotes some interesting examples of cases which have come under observation.

The cases quoted so far show amusia accompanied by aphasia. This is not an invariable rule. Thus there is an instance on record of a man of 48 who suffered a stroke of apoplexy, in consequence of which he completely lost his sense of rhythm and melody, and became absolutely unable to play the violin as he did before his illness. In other respects the initial symptoms which followed upon the apoplectic stroke had long passed away, while the amusia persisted as far as the record extends.

Aphasia and Agraphia with Musical Alexia and Musical Apraxia.—N. N., an unmarried woman, suffered an apoplectic attack in 1885, followed by aphasia, agraphia, and slight paralysis of the right arm and leg. These symptoms, save only the motor aphasia, which never entirely disappeared, were soon recovered from. Later, however, about a year and a half after the attack, she developed a psychosis and remained under treatment in an institution for nine years. Thereafter she lived with her sister, her mind lucid, her memory more especially being particularly good. When somewhat recovered from her apoplexy it was discovered that she had entirely lost her musical faculty. Still later, at a time when she was able to pronounce simple words only, she began to regain it. Sitting at the piano one day, it was quickly evident that while the tone and key (motor) memories of the left hand were intact, those of the right had entirely disappeared. Hence while the bass notes were correctly struck those higher up gave no sound, her right hand wandering in an uncertain questing kind of way over the treble end of the keyboard, but without touching it. Yet, despite this ineptitude of the right hand, her melodic memory is said to have remained unimpaired; for she could easily call up the recollection of both parts—the bass and the treble quite as well. When she made these attempts to play, it now and then appeared that the fingers of her right hand struck the keys, but always the wrong ones. While this state of things existed her right hand and arm had already regained much of their old-time vigor, and co-ordination was sufficiently good to enable her to write. Gradually she regained the ability to play with her right hand, and ultimately she was able to play by ear and memory in much the same way as before the attack. She was also able to compose minor music. The ability to play by note was, however, permanently lost. This case is interesting for a variety of reasons, but more especially because it is a unique instance of what Würtzsen calls a malady of the "key-memory." As for the location of the lesion which is responsible for the occurrence of the phenomenon, he holds that we must look for it in the left hemisphere, more especially in Knoblauch's "Tone-movement image" center.

Aphemia, Word-deafness, Word-blindness, Agraphia.—A man, 50 years old, had a cerebral hemorrhage, followed by hemiplegia of the right side, with loss of the power to speak or understand what was said to him, or to read or write. One day he began to sing a few bars from a melody, but without words. Since this first attempt he has frequently done the same thing, always singing the same fragment and always in the same way.

Aphemia, Partial Vocal (Motor) Amusia.—Patient, a woman 55 years old. Attacks of vertigo, followed by partial paralysis of the right arm with loss of power to speak or understand what was said to her. Recovered somewhat from the paralysis and regained the ability to understand what was said to her. Was never able to read or write. Formerly was able to sing many melodies; at present can sing but part of a melody when the name of the song is mentioned. Can repeat a song when it is sung to her and recognizes popular melodies.

Word-deafness, Tone-deafness.—Bernhardt gives the history of a man who was seized with vertigo, followed by right hemiparesis. A few days later he was restless and spoke very indistinctly. Still later, examination showed that he could write and read (aloud) and was able to hear tones and voices, but was unable to understand what was said to him. When he spoke he frequently mixed his words. Tests showed that he was unable to comprehend melody, which seemed to him like noise—now "high," now "low."

Brazier gives the following histories of two cases of complex (mixed) or total amusia, occurring suddenly, the one in a singer, the other in a pianist: "In 1873, Barre, a tenor who was singing the important part of Petite Fadette at the Opera Comique, was suddenly seized one evening in the midst of the performance by total musical amusia. Neither the orchestra nor his associates, who sought to prompt him, succeeded in reviving his memory. He no longer understood what they were singing, nor could he emit a single note. On reaching home he was perfectly able to understand what was said to him in ordinary language and to reply intelligently, but everything—words and music—which bore any relation whatever to the work which he had been singing, or, indeed, to any part of his entire repertoire was completely forgotten. He recovered in a few months and was able to resume his lyric activities."

Brazier's next case is that of the eminent pianist, Prudent, who, it seems, was endowed with a prodigious memory: "One day, about 1852, while playing in public with orchestral accompaniment one of his own concertos, he suddenly lost all memory of things musical. At that moment his work was for him nothing more than incoherent noise; not a phrase of the orchestra, not a melody did he comprehend. Coincidently there was absolute inability to play even from notes. He went abroad the following day, having largely recovered, but henceforth played only with the notes before him."

Disorders of the Musical Memory Due to Hostile Emotions; Imperative Concepts (Psychasthenia) and Intoxication.

Besides the disorders of the musical memory due to gross lesions of circumscribed areas of the cortex, there are others, which, while obviously functional in origin, are capable of causing not only great distress to the subject, but even his complete artistic undoing. Several cases of this kind, some of them occurring in artists of the first rank, have come to the professional knowledge of the writer. The following are a few instances:

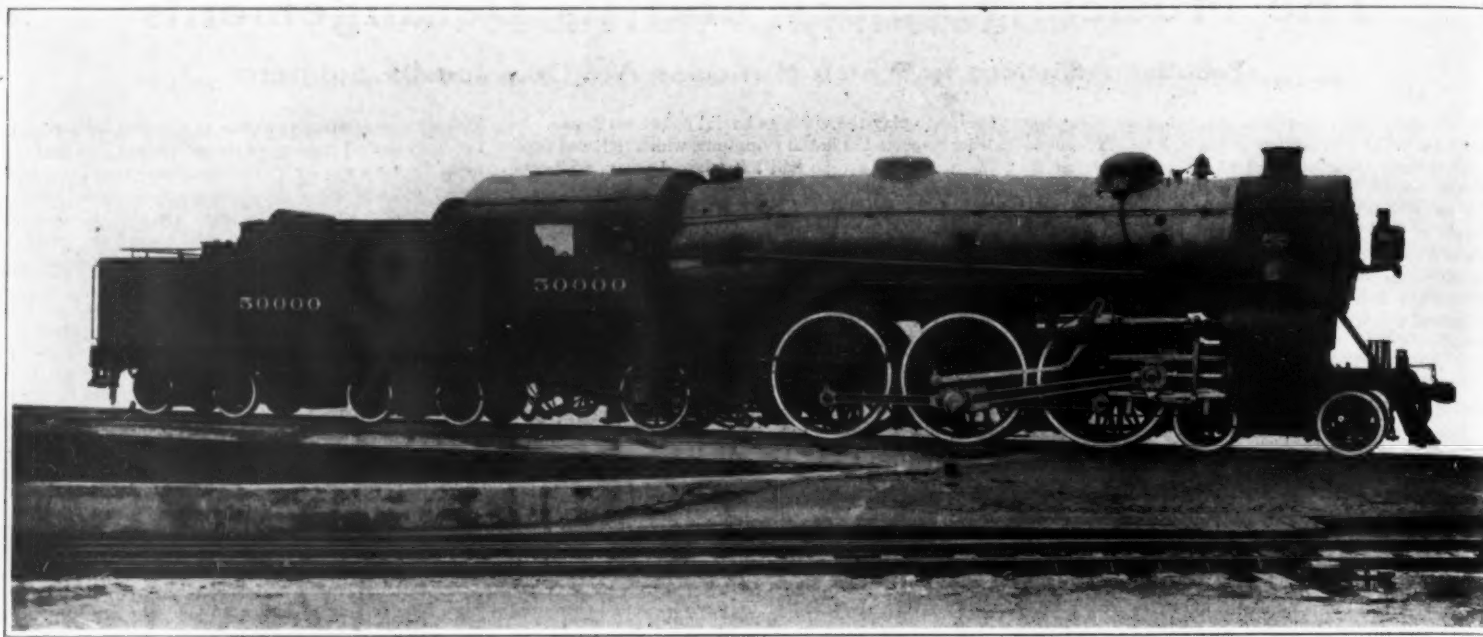
M. I. T., soprano of thirty-five, temperate, fine physique; never seriously ill, came to me with the following history: For several years—in fact, since the inception of her career as a church and concert singer—she had never been able to sing in public without the aid of copious stimulation, usually in the form of champagne, being so overcome with dread of a possible vocal mishap that her appearance in default of such assistance would, in her judgment, have been impossible. Wishing to put the matter to the proof, I prevailed upon her to attempt to sing for me without the accustomed prop, only a few other persons being present. When, however, it came to the test, she became greatly agitated and, declaring "that everything swam" before her eyes and that she "could remember nothing," sank down upon the sofa, trembling violently. A pint of champagne was given her, when presently, having gained her composure, she repeatedly sang with superb voice and in perfect style. It was the unanimous verdict of those who listened that her voice would have been an ornament to any stage. "Yes," she replied to this enthusiasm, "I have had many opportunities to sing in opera, but my infirmity, of which you have just been witness, has always stood in the way."

Later when the writer again saw her she was questioned as to her early life and education, with the hope of gaining a clue to the genesis of her trouble. Such a clue was not long in appearing. As a girl she had had, it seems, for some years as a vocal teacher an individual of violent and brutal temper, who, whenever she was guilty of a mistake, would strike her with a rod, heaping opprobrium upon her, at the same time, in the most abusive language. The effect of this ill-usage was to despoil her of both interest and confidence; to deprive her of self-possession, and, ultimately, to engender such dread of her own fallibility that she was otherwise powerless to cope with it save in the manner previously set forth. In her case stimulating medication, coupled with suggestion, was of sufficient avail to enable her after some time to sing without alcohol.

That children frequently sing before they talk; that idiots who are unable to talk sometimes sing; that drunken men often sing when they cannot talk, and that many birds sing, although they cannot be taught to speak, are some of the facts adduced in support of the contention that the cerebral (cortical) mechanism connected with musical representations is independent of that connected with those of speech. As an offset to this evidence, however, we are confronted by the fact, already sufficiently accentuated, that, while the musical faculty is sometimes preserved or largely preserved in aphasia, it is impaired or totally lost in a large number of well-authenticated cases.

How are these conflicting data to be reconciled? By what jugglery of inference are we to be put in the way of arriving at a theory which, even in moderate degree, shall comport with the exactions of common sense? Rather than invoke a factitious, though seductive semblance of solution, Dr. Corning confesses that in the present state of knowledge he is unable to frame an answer. Neither the pathological material nor the clinical histories associated with them are, in his opinion, either sufficiently abundant or of such a character as to afford the groundwork so necessary to a final solution of the problem. Nor is this to be wondered at when one considers the relatively small number of highly educated musicians, whose demise, conjoined with the favoring fortuities of complete clinical histories and carefully conducted autopsies, might, conceivably, yield the necessary data. If we hold that the centers of musical representation and the centers of speech representation are identical, then we must admit, according to Brazier, that nervous elements which have become impotent for a certain order of representations (those of speech) remain active, nevertheless, in so far as certain others (those of music) are concerned. Or, that the areas connected with musical representations lie near those of speech.

* After J. Leonard Corning, M.D., LL.D., original paper published in *The Medical Record*.



Locomotive Number Fifty Thousand

An Experimental Pacific Type Designed With All Modern Improvements to Provide the Maximum Power Per Pound of Weight

Records made by the 50,000th locomotive of the American Locomotive Company, designed and constructed at their own expense, as an experiment, prove it to be an epoch making locomotive comparable in its own field of service with the new mountain type of the Chesapeake and Ohio Railroad built by the same company.

In tests in actual service it has already developed 2,216 horse-power—one horse-power for every 121.4 pounds of total weight, both of which exceed any passenger locomotive of which we have record.

Compared with one of equal weight and of conventional design, this locomotive has shown an economy in fuel in excess of 25 per cent.

This locomotive, a Pacific type, illustrated herewith, was developed in consequence of the thoroughly appreciated need of greater sustained capacity to meet the maximum requirements of modern passenger service. It represents an effort to determine the limits to which the efficiency and capacity of a passenger locomotive of a standard wheel arrangement could be developed without exceeding conservative weight limitations through the fullest application of the latest approved developments in locomotive design and materials. In other words, to secure the maximum sustained capacity per pound of weight.

It embodies the latest knowledge of general proportions, the most recent developments in materials and improvements in the design of details combined with the best use of approved fuel saving devices to secure the utmost possible economy of the locomotive as a whole from the operating standpoint.

Many improvements over long accepted conventional practice in the design and construction of some of the principal details introduced in this locomotive have since been adopted as standard practice by the builders and widely applied to a large number of other locomotives with marked success from the viewpoints of all, from the general manager to the engineer.

For these reasons, this locomotive marks a distinct and definite advance in locomotive engineering.

The most pronounced and important lines along which progress in locomotive development has followed during the past year, are, we believe, a most careful attention by the locomotive builders to the selection of correct proportions based on the accumulated data secured from recent exhaustive investigations, analyzed and reduced to standard practice, and the revision and modification of conventional practice in the design and construction of standard details, combined with the application of fuel saving devices with the view of securing from each device its fullest value in fuel economy and increase in capacity for the same amount of coal burned. This locomotive, here illustrated, seems to us to represent the highest expression of this development.

Untrammeled by any outside specifications or the necessity of conforming to any railroad's existing standards, the builders had free hand to embody in this design their ideas of the best locomotive practice.

To accomplish the purpose of the design—the maximum capacity per pound of weight—the largest boiler capacity within the predetermined wheel loads was the essential feature.

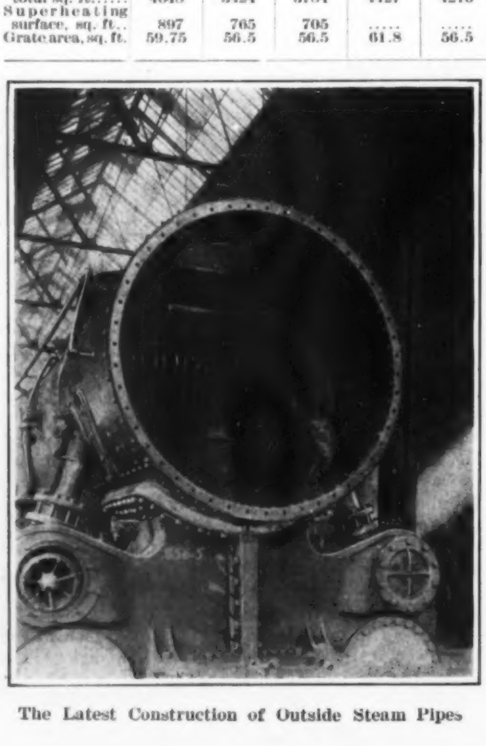
This end was obtained by eliminating every pound of weight in all the parts that was not necessary to strength or durability and by utilizing the weight thus saved to provide a larger boiler and by increasing the capacity of the boiler thus secured by the use of fuel saving devices to obtain the utmost economy in boiler and cylinder performance.

The design and construction of the boiler is shown in one of the accompanying illustrations.

The following comparison of locomotive No. 50,000 with other leading examples of Pacific type locomotives of approximately equal weight shows strikingly the larger boiler provided in the former in proportion to its weight.

Comparison of Boiler of Locomotive No. 50,000 and Those of Other 462 Type Locomotives of Approximately Equal Weight.

	50,000	A	B	C	D
Total weight of locomotive, lbs.	269,000	269,000	271,000	270,000	266,500
Type of boiler	Conical connect.	Conical connect.	Conical connect.	Straight.	Conical connect.
Heating surface, total sq. ft......	4048	3424	3784	4427	4210
Superheating surface, sq. ft..	897	765	705	.....	.....
Grate area, sq. ft.	59.75	56.5	56.5	61.8	56.5



The Latest Construction of Outside Steam Pipes

Note that the boiler of the locomotive No. 50,000 has 624 and 264 more square feet of evaporative heating surface combined with from 132 and 192 more square feet of superheating surface than the other two superheater locomotives, respectively, which are of equal or greater weight.

Compared with the two locomotives not equipped with superheater, the locomotive 50,000 has at the most only 379 square feet less of evaporating heating surface, which is undoubtedly three or four times offset by the economy secured with the 897 square feet of superheating surface. This is the largest amount of superheating surface provided in an American passenger locomotive up to the present time, and results in realizing greater economy in operation from this feature, owing to the greater degree of superheat attained, as is proved by test records.

Compared with another locomotive of equal weight, also equipped with superheater, but of less superheating surface, and giving an average of 63 degrees less superheat, the locomotive here illustrated showed in service tests an average greater economy of 13 per cent in fuel and 14 per cent in water consumption per indicated horse-power per hour.

In these tests, the locomotive No. 50,000 reached a maximum superheat of 341 degrees with an average of 276 degrees, which we believe to be the highest record for any American locomotive.

The superheater is of the type "A" with top header and double looped superheater tubes. It consists of 36 four-tube superheater units. A damper of the usual design is provided which automatically regulates the flow of gases through the superheater flues when the throttle is shut off.

To further increase the boiler capacity through improved boiler economy, the firebox is equipped with a "Security" sectional brick arch. Aside from this large boiler capacity, the number of new features introduced in this design with a view both of saving weight and securing improved economy in operation make this locomotive one of the most interesting of recent construction.

Among these new features, the following principal ones deserve particular notice:

Cast steel cylinders with cast iron bushings.

Steam pipes arranged to connect with the cylinders outside of the smoke box.

Screw reverse gear.

A self-centering guide for the valve stem.

A new arrangement of guide for the extended piston rod end.

Improved outside bearing radial trailing truck.

Most of these features, modified somewhat in structural features, have since been adopted into the builder's regular practice and have been extensively used on locomotives since built by them. These are shown in detail in their latest form in the accompanying illustrations. Credit for them, however, really belongs to locomotive No. 50,000, as it was the building of this experimental engine which led to their development.

CAST STEEL CYLINDERS.

This is the first instance of the use of cylinders of this construction in American locomotive practice. The cylinders are of vanadium cast steel, and this constitutes probably the most radical of the departures from conventional practice in this design.

This construction was adopted in order to save weight. As a result, the 27 by 28-inch cylinders with which the locomotive is equipped, weighs 2,660 pounds less than ordinary cast iron cylinders 22 inches in diameter and the same stroke bushed with cast iron.

On the other hand, cast iron cylinders of this size for inside steam pipes would have weighed approximately 4,000 pounds more.

OUTSIDE STEAM PIPES.

This arrangement was really necessitated because of the application of cast steel cylinders as it is the only practical method of construction with cylinders of that material because of the resulting simplification of the castings.

Because of its many advantages, the outside steam pipe construction first introduced into this country on the locomotive here illustrated, has been very favorably received by American railroad men. It greatly improves the steaming capacity of the boilers because it removes much of the obstruction to draft in the smoke box which is present with the steam pipes of conventional design.

SCREW REVERSE GEAR.

By the use of the screw reverse gear instead of the ordinary lever, locomotive No. 50,000 introduced what promises to be a most important and beneficial change in American locomotive practice, both from the standpoint of economy and ease of operation.

In the large locomotives of the day it is becoming more difficult every year to handle the reverse lever easily. As a result, considerable loss in economy and efficiency in operation ensues from the fact that steam is not used expansively with full throttle and cut-off arranged at the most economical point. This is due to the fact that when any speed is attained it is often a risk to change the reverse lever because of the liability of the lever getting out of the hands of the engineer.

The screw reverse gear can be easily arranged to give about eleven times the leverage obtained with the reverse lever as usually proportioned. The wheel can be spun around very rapidly so that only from four to six seconds is required to completely reverse the gear, which is probably faster than can be done with the ordinary reverse lever because of the time consumed by the engineer in getting into position and well braced before he can exert sufficient force to throw the reverse lever.

SELF-CENTERING VALVE STEM GUIDE.

Another important improvement in detail design introduced in the locomotive here illustrated with which American railroad men are now familiar because of its extensive application to other locomotives recently built by the American Locomotive Company is the self-centering design of guide for valve stem. It consists of a guide made integral with the back head of the piston valve chamber and so constructed as to be easily adjusted for wear. The chief advantages of this arrangement is that it can be erected, taken down and replaced without any lining up, at the same time insuring that the valve stem guide is absolutely in line with the piston valve chamber.

The new standard design of guide for the extended piston rod, which in view of the general adoption of this practice on locomotives equipped with superheater has a wide usefulness, is one of the important improvements in this locomotive. This device, like the valve stem guide is self-centering and can be removed and replaced in position without lining up, and at the same time exactly coincides with the longitudinal axis of the cylinder.

Truck With Floating Spring Yoke and Ball-spring Seat Support.

IMPROVED OUTSIDE BEARING TRAILING TRUCK.

A considerable saving in weight of about 5,000 pounds was affected by the application of the American Locomotive Company's improved design of outside bearing radial truck in place of their former type which entailed the use of outside supplementary frames secured to the rear portion of the main frames by heavy cast steel filling pieces. This type of truck had been previously successfully applied and has since become the builder's standard design for Pacific and Mikado type locomotives so that it needs little description.

PRESSED STEEL BUMPER AND PILOT.

Further evidence of the refinement in detail carried out in this locomotive to keep the weight of every part down to a minimum consistent with strength is furnished by the use of a pressed steel bumper and pilot. The latter construction has been very successfully employed on the Lake Shore and Michigan Southern Railroad. Compared with an ordinary design of cast steel bumper the pressed steel type here employed weighs approximately 1,200 pounds less, while as between the pressed steel and wooden pilot there is a difference of 350 pounds, a total saving of some 1,500 pounds being secured in these two details alone.

VANADIUM STEEL.

Additional strength without increased weight is secured by the liberal use throughout the design of vanadium steel for many of the principal parts. Some of the parts constructed of this alloy steel are driving wheel centers, frames, rods, piston rods, valve motion work, springs and crank pins. Vanadium was also used in the cast steel cylinder and in the cast iron cylinders and valve chest bushings.

Locomotive No. 50,000 sets a new high mark for the capacity and economy attainable within the limitations of conservative wheel loads in a modern passenger locomotive designed for sustained high speed service with heavy loads.

It has also pointed a way by which present practice may be greatly improved by better proportion of boiler to engine capacity, greater refinement in the design of details and modifications of present standards, the best use of fuel saving devices, the value of which has been tried and proven in service and the latest developments in material.

There is not another instance in the history of American locomotive development in which locomotive builders on their own initiative and at their own expense have constructed a locomotive—not to introduce a new principle; but to secure information as to the maximum possibilities in economy and capacity inherent in already adopted principles with the view of the advancement of locomotive design.

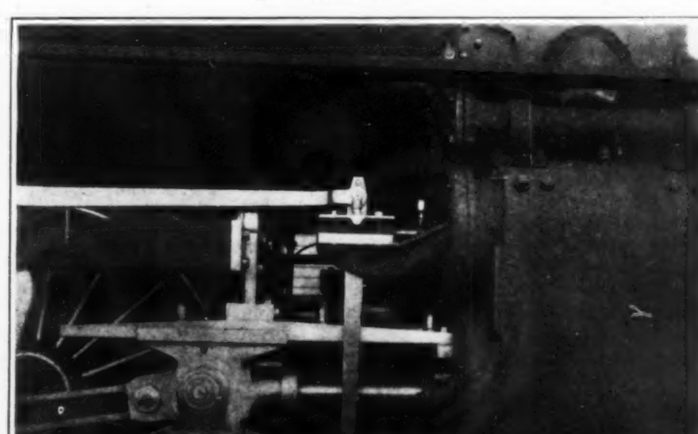
For these reasons, this locomotive merits investigation and the most careful study of all the details of its design on the part of all railroad officials interested in locomotive operation and its performance on the Erie Railroad on which it is running should be closely watched.

In this connection a report published in the *Railway and Engineering Review* of a trip recently made on the engine, is of interest: "The locomotive hauled train No. 5 on the Erie Railroad, leaving Jersey City at 7:55 P. M. It was made up of one postal, one combined car, two day coaches, one dining car, three Pullmans and one private car, the train having a combined weight of 546.2 tons. The lading was estimated at 60,700 pounds, making the total weight of the train, without engine and tender, 576.55 tons. At the Jersey City station the forward half of the train lay on a curve. The enginemen moved the screw reverse to full gear forward and at once opened the throttle about one-third and then one-half. The resultant train movement was very easy and smooth. There was absolutely no slippage, and in spite of a considerable gradient through the second half mile after starting, very rapid acceleration commenced, the acceleration being sufficiently easy and rapid as to give the impression that the engine was moving light.

"One of the most remarkable features noted in the operation of the engine was the fact that during the entire run, at low speeds as well as high, and whether on gradients or level track, on curves or on tangents, the throttle was not removed from the mid-position on its quadrant, and all variation in the quantity of steam demanded by the cylinders were met by changes in the positions of the screw reverse. It was a surprise to note the ease with which the fireman could maintain the steam pressure. Firing was intermittent and usually at the rate of about three shovelfuls to one door, then after a brief interval an equal number to the other door. A safe estimate would be that the fireman worked up to about one-half his capacity. The good steaming qualities of the boiler are undoubtedly due to the superheater, the brick arch, and to the air-operated fire doors, the latter holding the influx of cold air to the fire box down to the minimum.

"The locomotive was excellently handled by the New York division crew, which seemed to be very familiar with its operation. The engineman had nothing but praise for the screw reverse, which he declared to be his especial pet. The fireman was very much enthused over the air-operator fire doors, claiming that their practical and reliable operation was the means of saving a large amount of physical labor. Both were ardent in their praise of the fire-tube superheated and the brick arch, in that these contributed possibly as much as anything to the great reserve capacity, the easier firing and the better steaming qualities of this engine as compared with the present class of Pacific type locomotive in use on that road, although it is the consensus of opinion that the latter engine, size for size, is a hard one to improve upon. The new locomotive was not forced to the limits of her capacity at any time during the run, and it has been admitted that it has solved the passenger locomotive problem on the New York division."

Self-centering Extended Piston Rod Guide.



Side View Showing Self-centering Valve Stem Guide.

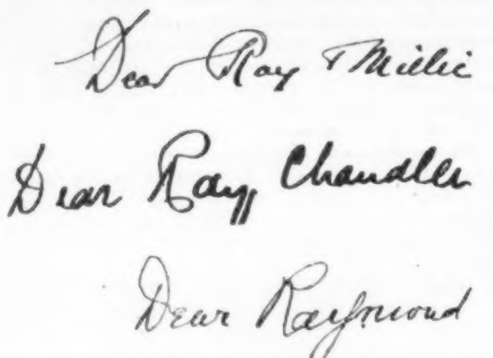


Fig. 1.—Three Brothers' Writing. The First Two Are Especially Close in Resemblance.

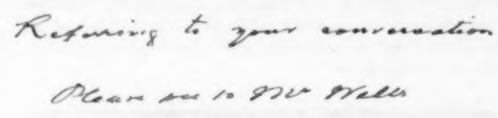


Fig. 2.—The Handwriting of Two Brothers Are Almost Undistinguishable.

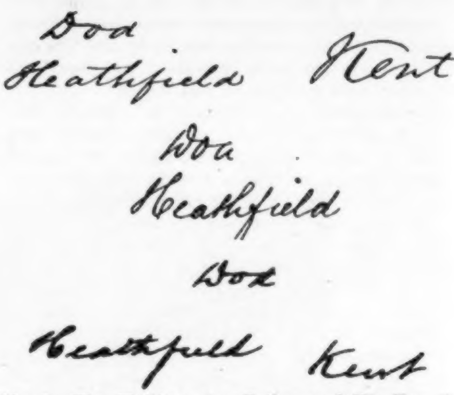


Fig. 3.—The Writing of a Father and His Two Sons.

Handwriting as a Clue to Mental Traits

A Key Not Only to a Person's Character But Also to His Temporary State of Mind

THE art or science of reading character from handwriting is of quite remote origin. We gather from an article by Dr. G. Schneidemühl, in *Die Umschau*, that as early as 1622 Camillo Baldo, a Bologne physician, published a treatise, "The Manner and Means of Inferring a Person's Character and Qualities from His Handwriting." Later such noted men as Leibnitz, Goethe and Lavater seriously occupied themselves with the subject. Probably many of our readers have at some time or other taken an interest in this matter and have amused themselves by applying the principles set forth in various books published on the subject, to the examination of the handwritings of their friends. Occasionally, too, serious use may be made of this means of gaging a person's character, as, for instance, in glancing over letters received in answer to an advertisement issued to fill a vacant position. Needless to say, in such a case caution must be exercised, unless the person is thoroughly conversant with the art.

The purpose of the present article is not to deal with the general subject, which has been discussed at length over and over again, but with one or two special phases. One of these has been referred to in an article published a little while ago in the SCIENTIFIC AMERICAN, namely, "The Manifestation of Family Likeness in the Handwriting." We reproduce here a few of the most important examples previously shown.

FAMILY HANDWRITING.*

The likeness which exists between the writing of various members of the same family is often exceedingly strong, and for the purpose of a just comparison it is necessary to have the same words written by related people. The names and addresses on envelopes are very useful, though, as these are written carefully when they are unknown, it would be better to have a few familiar words written without hesitation. The family likeness in the illustrations here given is apparent to anyone, and it would be easy in some instances to mistake one for the other. Take Fig. 1, the first two samples, two brothers; Fig. 3, the first two examples, father and son; Fig. 2, two brothers; Fig. 4, two sisters, or Fig. 5, three brothers, of which the first, and second writings are hardly distinguishable one from the other; and even where the likeness does not approach almost to identity (as in the instances just given) there is a very strong family likeness in formation and style—take Fig. 6, showing brother and sister, where the style is pronounced and very similar, or Fig. 1. Fig. 7, shows the round handwriting of a father and son (if it were possible to show the signatures the likeness would be very much stronger) and Fig. 5, which shows a strong likeness in the angularity (or acuteness) of the handwriting of three brothers.

* Adapted from R. H. Chandler's article in *Knowledge*.

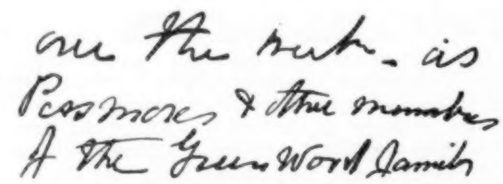


Fig. 4.—Two Sisters, With Almost Identical Writing. The Word "the" Should Especially be Compared.

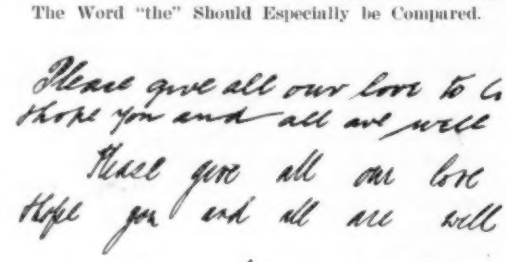
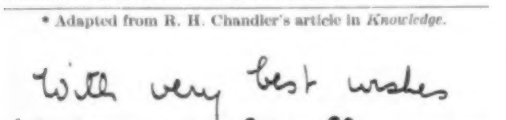
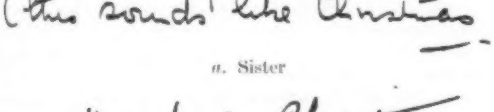


Fig. 5.—Three Brothers. The First Two Writings Especially are Closely Alike.



a. Sister



b. Brother

Fig. 6.—There is a Likeness in General Form and Style.

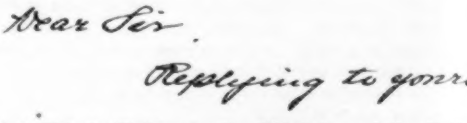
Characteristic peculiarities common to several members of a family are astonishingly exhibited in some of our illustrations. Take Fig. 9, which shows the rapid writer's trick of running the words together; the peculiar formation of the "r" of "dear," and the "Ch" of "Chandler." Fig. 3 shows the writing of a father, aged about seventy, and two sons, both of whom have inherited a peculiar capital "D," "H" and "K." In Fig. 4 the writing is not a characteristic one, but the "the" in each case is identical and the "e"s are blind. Fig. 8 shows the handwriting of a father and son, and superficially one would say there was no likeness between them; but notice the capital "C"s and "B"s, the flourish at the end of "Chandler" in the father has become a detached dash in the son; they both put "etc." or its equivalent after "Builder" (whose "e" is a Greek one in both cases) and they are liable to stop the pen at the same places—in the word "Chandler" they both leave a space after "h" and "n" in "Builder" after "l," and in "Belvedere" after "v" and "e." This last instance is very curious; for there is no apparent reason for leaving the "e" in the middle of the word all by itself when the four letters both preceding and following it are joined together.

A curious case is presented by Fig. 3, first example, which shows strong hand writing for a man of seventy, whose peculiarities are exhibited in two of his sons, but the eldest son, Fig. 7, first example, writes totally unlike the rest of the family, and yet he, has bequeathed his own handwriting to his own eldest son, Fig. 7, second example.

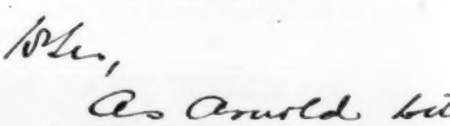
These illustrations are sufficient to prove that handwriting is hereditary (sometimes to a remarkable extent), and in some instances environment can have had very little to do with it, but in many cases we know so little of the influences brought to bear upon such a flexible growth as handwriting, that it is quite possible to underestimate the effects of environment.

THE WRITING OF HYPNOTIZED PERSONS.

A most extraordinary example of the extent to which a person's handwriting corresponds not only to his general character but to actual temporary states of mind, is presented by a number of samples of writing obtained from hypnotized media. It is found that such persons display with surprising force the characteristics of the subjects whom they are impersonating. It may seem at first sight almost incredible that this should be the case, and yet when we consider the scientific explanation of the phenomenon of character manifestation in the handwriting, we find that this behavior of hypnotized persons is only what we should expect. For, according to the modern view, the various peculiarities presented by a person's handwriting are only special instances of similar peculiarities exhibited in all their gestures and movements, and it is found that certain states of mind and certain moods are accompanied by certain types of gestures and movements; thus, for instance, a person in a cheerful and energetic mood, or a person who habitually entertains that state of mind, tends to make use of upwardly-directed gestures,



(a) This is Written by the Third Son of the Father Whose Writing Appears in Fig. 3.



(b) Written by the Son of (a).

Fig. 7.—The Roundness of the Writing in Both Cases is Striking.

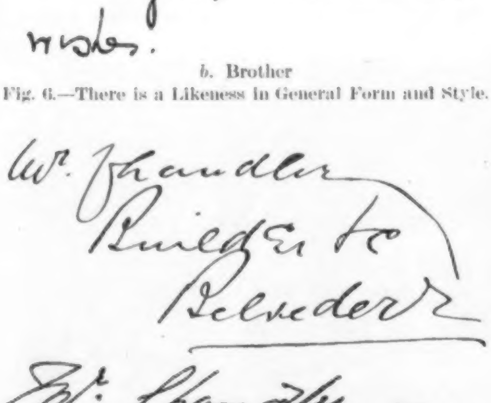


Fig. 8.—Father and Son. There Are Many Points of Similarity. Note Especially the Identical Mode of Division of the Word Belvedere.

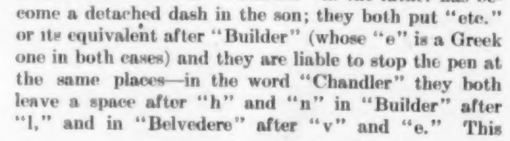


Fig. 9.—Two Brothers. The Words Are Joined and There is Great Similarity in Style.

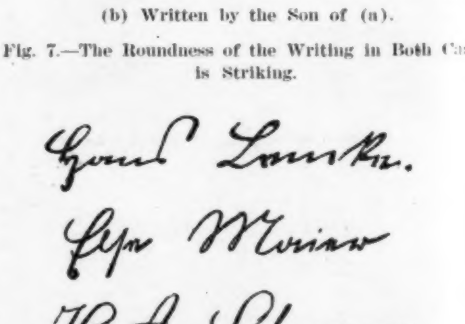


Fig. 10.—A. Hypnotized Medium Signature Impersonating Different Characters.

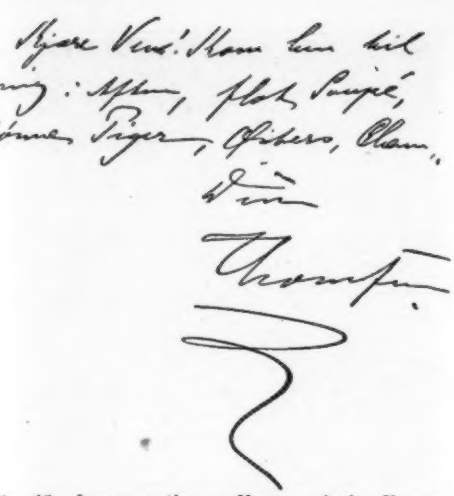


Fig. 12.—Impersonating a Happy-go-lucky Young Spendthrift.

while, on the contrary, a person of the melancholy type displays the opposite tendency. This shows itself very clearly in handwriting. As is well known to all who have studied the matter, the handwriting of a person in a state of depression betrays his condition by the downward inclination of the words, and sometimes of the lines. Some very extreme cases of this kind are known to the writer. On the other hand, persons of

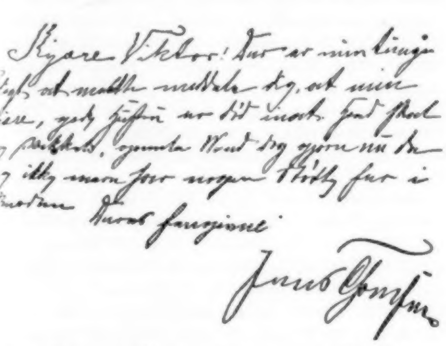


Fig. 14.—Impersonating a Seventy-year-old Widower Lately Bereft. Note the Downward Slope of the Words and Lines.

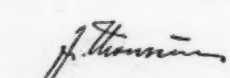


Fig. 11.—Natural Signature of Medium Subsequently Hypnotized to Impersonate Various Characters.

energetic, cheerful and ambitious temperament tend to give an upward slope to their words and lines. From the explanation which has been given above, it is perfectly evident that the cause of a person's mood is immaterial in this matter, so that we should only expect that a hypnotized person will show in his writing the characteristics of the subject which it has been suggested to him to impersonate. Some very interesting examples of this kind are shown herewith. Fig. 12 shows the natural signature of a certain medium. Fig. 11 shows him impersonating a happy-go-lucky young spendthrift. Notice the unnecessarily extended terminations of the final letters. The handwriting in Fig. 13 is that of the same subject, this time impersonating a twelve-year-old schoolboy. The fourteenth illustration shows the same subject impersonating an old man, seventy years old, who had just lost his wife. Note the downward slope of the words and line.

In Fig. 15 is shown the result of the same subject having suggested to him the impersonation of a young girl full of life. Note here again the long extended terminal letters, a sign of a certain dash and freedom from care and a tendency to spend somewhat lavishly. The last illustration is remarkable. Here the subject is impersonating Napoleon. Note the large letters and the long sweep of the end of the initial "N"—an indication of determination and energy.

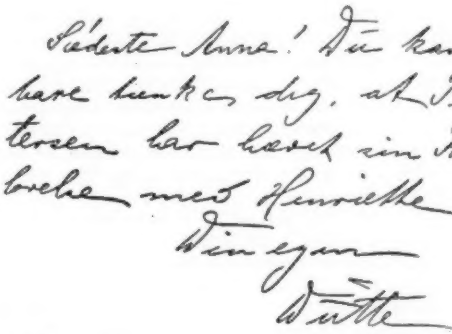


Fig. 15.—Impersonating a Young Girl Full of Life

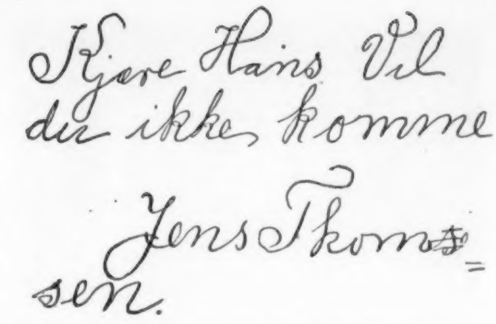


Fig. 13.—The same Medium Acting the Twelve-year-old School Boy.

Another example, taken from *La Science au XXe Siecle* is shown in Fig. 10. Here the medium successively impersonates a pupil of the primary grades, a girl of thirteen, Prof. H. A. Schwarz and the anarchist, Müller. The writing in each case is exceedingly characteristic.

Examples might be multiplied, but enough has been shown to make it very clear that a person's handwriting not only discloses his natural character, but is even influenced by the temporary emotional moods, in a manner which gives to the careful observer unmistakable clues to the writer's frame of mind.

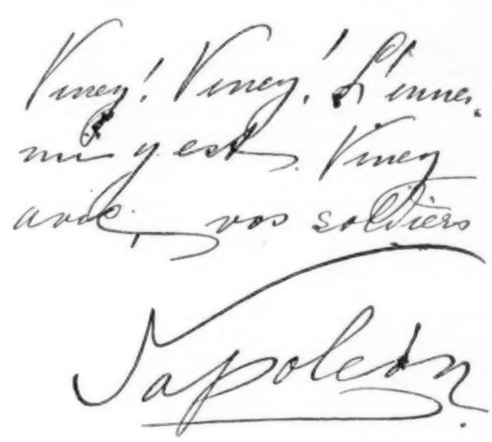


Fig. 16.—How the Medium Felt as Napoleon I.

Some Triumphs of Modern Surgery

Dr. H. Tillmanns, writing in *Reclams Universum*, gives a review of some of the achievements of modern surgery—an account which to the uninitiated reads almost like a fairy tale.

In some respects surgery has the advantage of medical practice in that not infrequently the surgeon has it in his power, by some operation, to completely eradicate some diseased condition and restore the patient to absolute and complete health in a comparatively short time. Partly on this account, and partly owing to a certain element of risk which always enters into every operation, and which, in desperate cases, may be very great, there is something dramatic about the feats of surgery. Dr. Tillmanns first of all gives us an insight into the history of chirurgical art, and here, too, the layman may find some statements which come to him very much as surprises. Thus, for instance, we naturally think of the operation of trepaning, that is to say, of opening the skull to operate upon the brain, as extremely serious and difficult. As a matter of fact, it was described as early as the fifth century before Christ, by Hippokrates, who mentions it as having been long known even in his day, though only rarely resorted to. There is evidence that trepanation was occasionally performed even in the prehistoric stone age, and at the present time some primitive tribes occasionally carry out successfully this operation. It seems well nigh incredible that these savages should open up a skull, as they do, by means of a sharp piece of flint, obsidian, a shark's tooth or a sharp mussel shell. For an antiseptic the natives of the South Sea Islands used a liquid obtained from the cocoanut. Parkinson, in his book, "Thirty Years in the South Sea," mentions that a certain "medicine man" carried out trepanations on thirty-one patients, of which twenty-three survived. At the present day, the practice of trepaning is of course well developed, and the spinal cord also has been rendered accessible to surgical treatment.

In operating upon the organs of the thorax, the great difficulty is to prevent the collapse of the lungs through the entrance of air into the thoracic cavity. Modern technique has overcome this difficulty by special devices for maintaining a regulated pressure upon the organs of the thorax. Great progress has been made in the surgery of the lungs and heart. Valuable assistance in this work is rendered by the X-ray apparatus, which renders it possible to make a correct diagnosis. Operations carried out upon the lung may consist in suturing a wound or splitting the lung, usually by means of a red-hot cauterizer. Sometimes, too, a portion of the lung or even an entire lung is removed. Dr. Tillmanns informs us that in one instance a patient (a merchant) was able to return to his work after the complete removal of the right lung and the translocation of his heart from left to right.

The surgery of the larynx has of recent years also made great progress, especially in cancerous cases. The earlier the operation is performed the greater the chance of saving the larynx. In some instances the entire larynx has been removed, and as the result of modern methods this operation is not now as dangerous as it used to be, and not infrequently leads to complete cures. After the complete removal of the larynx and thorough healing of the wound, it is customary to insert a so-called "false larynx," that is to say, a vocal organ, which enables the patient to make himself understood. However, even in extreme cases, it is usually possible, by proper training, to develop the ability to speak by the aid of the soft parts of the fauces.

The surgery of the heart shows wonderful successes in recent years. In a number of cases heart wounds have been healed by suturing. The necessary condition for success here is that the operation should be carried out very soon after the injury is received. There are now on record some 160 to 170 cases of sutured heart wounds, of which about 70 recovered. The course of such an operation is to first of all lay bare the heart by opening the thorax; the pericardium is then split, and the blood which has collected therein is drained out. The wound is then sutured. It is necessary to restrict the bleeding as far as at all possible during the operation, and this is accomplished by drawing out the heart and kinking it, assisting the effect by pressing the wound with the fingers and pinching off the large vessels at their entrance to the right auricle. It is found that the heart can withstand this treatment for from seven to nine minutes without harm. There are also a few instances on record in which foreign bodies, whose presence in the heart was disclosed by X-rays, have been successfully extracted. Lastly, it should be mentioned that the massaging of the exposed heart, in cases of collapse under an operation, is a treatment by which, in some instances, a seemingly dead person has been revived.

Taking a rapid survey of abdominal surgery, it may be mentioned that men have lived in comfort after the complete removal of the spleen or of one kidney. The liver, of course, cannot be dispensed with; the stomach may. Of the intestines, lengths up to ten and even sixteen feet have been removed without harm. In cases of injury by a gunshot wound, twelve to fifteen, and even more perforations in the intestines have been successfully closed by suturing, or by excising the affected portions. In such cases it is essential that the operation be performed very soon after injury, say within one to three hours.

So far we have been speaking of the important or most serious type of cases. We now come to a class which are not necessarily serious in character, the motive for surgical interference being sometimes purely human vanity. We are referring to so-called plastic surgery, the purpose of which is to remedy various defects and deformities produced by accident or in other ways. Thus, for instance, the loss of large patches of skin (which of course is a very serious matter) is repaired by grafting on skin from other parts of the body, such a grafted-on patch being left connected with its original tissue by a stalk. In some cases, if the injured part is too far removed from the portion of the body from which the patch has been derived, it may be possible to effect a double transfer, transplanting the patch first to one point and continuing the grafting process from there on.

As regards the plastic surgery of the nose, here again we find the surprising disclosure that this has long been practised by Indian physicians, who had extended occasion for such work, owing to the common punishment of criminals by cutting off their noses. Durable noses with Greek profile are built up with particular success by introducing paraffine or a bone, such as a finger or a toe.

The nerves also are treated surgically with much success. Bones also have been replaced by inserting extraneous bones, sometimes derived from an amputated limb or even from a corpse.

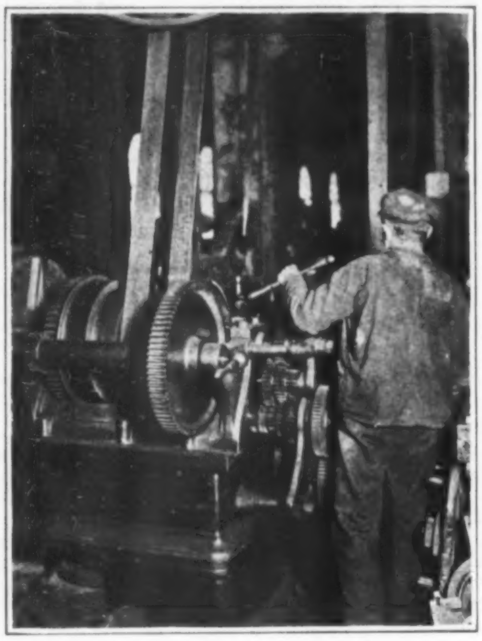


Fig. 1.—Exposed Gear Wheels at the Side of a Lathe Endanger the Passing Workman.

Scientific American Medal for Devices for Conserving Human Life and Limb.

Industrial Accidents and Their Prevention

Human Life as a Business Asset

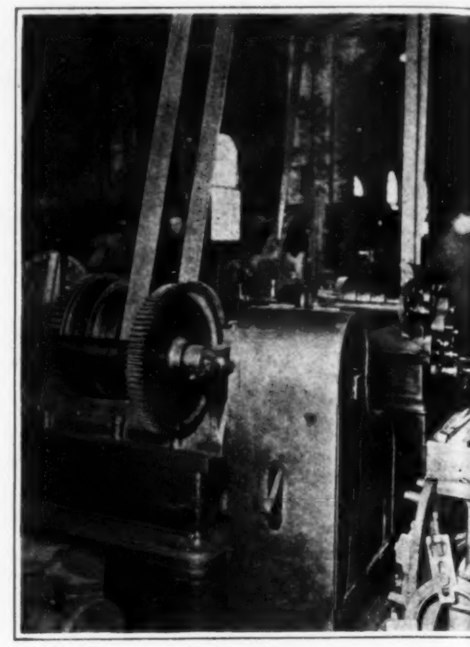


Fig. 2.—The Dangerous Gear Wheels Are Here Inclosed in a Protecting Hood.

There are several ways of looking at the question of industrial accidents to human labor and their prevention. The most obvious point of view, no doubt, is that of the workman himself, who has every right to demand that all possible precaution be taken to protect his life, his working capacity, and his well-being. Unfortunately not quite so obvious to every employer is the second aspect of the matter—the economic importance to him of the preservation of the health and good-will of his employees—though more and more is being done that shows a growing appreciation of this, the commercial side of the question. And thirdly, from the broad basis of the interests of the community, it is a mere truism to say that every injury to a working individual is a loss to the community and throws an additional burden upon his fellows, who directly or indirectly are forced to contribute to his support and that of his dependents.

To add to these three grounds for providing proper protection of the workman against industrial accidents, a fourth motive, in the form of philanthropic sentiment, seems quite superfluous, and indeed, one might ask whether a right-minded individual will consent to accept, as it were for charity, that which he seems from every point of view entitled to receive.

Before we go on to consider some of the very fine work that is being done, especially by some of the larger corporations, to mitigate the toll of human life and faculties which modern civilization must pay for its control of the giant forces of nature, it may not be amiss to recall a few facts and figures that will give us a concrete view of the situation. G. L. Campbell,[1] whom we shall have occasion to quote extensively in this article, prefaces his memoir on "Industrial Accidents and Their Compensation" with a quotation from Theodore Roosevelt's presidential message of 1908:

"The number of accidents which result in the death or crippling of wage workers . . . is simply appalling; in a very few years it runs up to a total far in excess of the aggregate of the dead and wounded in any modern war."

To cite actual figures, we may select a passage from a report on the conditions in Pittsburgh:[2]

"There is no respite. Each year turns them out as surely as the mills run full and the railroads prosper. . . . In five years there would be 2,585 [fatal accidents in Allegheny County]. Ten years would make it 5,170—enough to make a little city of cripples. It is no wonder that for a stranger Pittsburgh's streets are sad."

A good idea of the relative toll of accidents extracted by the industries and by other causes is obtained from the following table, taken from the Massachusetts Bulletin of Labor, and based on the report for 1905 of the decennial census for Massachusetts:

Persons Maimed in Massachusetts.

Causes of Injury	Number Maimed	Percentage of All Maimed
Occupational accidents	1,648	40.95
Non-occupational accidents	1,412	35.09
Disease	528	13.12
Military service	280	6.96
Not specified	156	3.88
Total maimed	4,024	100.00

1. "Industrial Accidents and Their Compensation," published by the Houghton, Mifflin Company, New York, 1901.

2. "One Year's Work Accidents and their Cost," by Crystal Eastmann, Charities and the Commons, vol. xxi, pp. 1143-1174.

"Further conclusions may be based on a study of the mortality tables of the United States Census. Of all deaths of adult males from 1900 to 1906, inclusive, 126,567, or 9.1 per cent, were due to accidents. 'How many of these accidents were the result of occupation, it is not possible to determine with absolute accuracy, but it is safe to assume that about one-half of the deaths from accident among males is the result of industrial employments.'[3]

"For two of the greatest and most hazardous of American industries, coal mining and railway transportation, accident figures have been gathered that are approximately complete.

"An astounding total of casualties is chargeable to the production of coal. The United States Geological Survey has collected figures of coal-mining accidents in 1907 and 1908 from twenty-two States, which produce 98 per cent of American coal. In 1907 this report shows 3,125 men killed and 5,316 injured; in 1908, 2,450 killed and 6,772 injured. In 1907 one man was killed for each 206 employed; in 1908, one for each 278 employed. In 1907, one man was killed for each 145,471 tons of coal mined; in 1908, one man was killed for each 167,545 tons mined. The Geological Survey has also found that 19,469 men were killed in the coal mines of the same States during the decade ending with 1908."

The following figures are taken from the mining reports of Pennsylvania and Illinois—two States which produce sixty per cent of the total output of American coal: "The compilation covers the decade ending with 1908, and shows that the average mine employee of these States has one chance in 234 of death from his year's work, and one chance in 138 of injury. If he looks forward to ten years' employment in the mines, he has one chance in 32 of fatal injury, and one chance in 14 that a non-fatal accident will befall him. The production of 178,266 tons of coal entails the loss of a life, while the production of 78,195 tons calls forth an injury. It is a striking fact that over thirty per cent of coal mine casualties are fatal, a circumstance doubtless due in large measure to the great disasters which command public attention so frequently."

An idea of the dangers to railroad employees can be gathered from the following figures, based on the Bulletins of the Interstate Commerce Commission:

"During the seven years ending with 1908, 23,895 employees were killed and 335,964 were injured on the railways of the country. A study of the ratios indicates that the average employee may count on one chance in 414 of violent death within a year. If he prefers to consider the prospect of injury, there is one chance in twenty-nine that an accident entailing at least four days' disability will befall him. If he looks forward to seven years of railway employment, he faces one chance in fifty-nine of death by accident, and one in four of injury. The outlook for a trainman is still worse. Of his fellow workers, 14,888 were killed and 218,982 were injured during the seven-year period. In a given year he has one chance in 127 of death, and one in nine of injury. Seven years in the train service offer him one chance in eighteen of death, and, if his place is one of average danger, present a practical certainty of injury."

3. *Bulletin of the United States Bureau of Labor*, No. 78, p 422.

After this desultory survey of the harrowing side of the matter, let us now briefly glance at the more cheerful aspect, and note some of the efforts that are being made to remedy a situation which is the natural outcome of our modern methods of dealing with giant forces, giants that are apt to turn and rend us if by mischance we for a moment lose our control over them.

"Many employers," says Mr. Campbell, "have voluntarily adopted schemes for substantial compensation. A favorite way of doing this is to allow wages to continue through the period of temporary disability. Out of 348 cases of injury to workmen in the State of Michigan in 1905, upon which reports were made concerning compensation, in 172 cases the employers allowed full wages to continue during the time of unemployment—an average of thirty-three days. The New York Edison Company pays about $10,000 a year in wages to injured employees. . . . Following one of the greatest disasters in the history of American industry—the fire on November 13th, 1909, in the mine of the St. Paul Coal Company at Cherry, Illinois—the voluntary settlements have been markedly liberal. Of the 258 men who lost their lives in the mine, 84 were single, 168 married, four were widowers, one divorced, and one unknown. Those married left 382 children under sixteen years of age. To provide for the immediate relief of the widows, orphans and other dependents, the coal company allowed wages to continue for about two weeks (as two weeks' pay was always held back, the payment of wages thus continued for four weeks following the disaster), and provided free rent and coal throughout the winter. The Chicago, Milwaukee and St. Paul Railroad Company, of which the coal company is in effect a subsidiary concern, was very generous in providing transportation facilities for the local relief committee. In February the officials of the coal company offered settlement on the basis of $800 to the heirs of each unmarried victim and $1,800 to each widow. This has been accepted in the majority of cases. Attorneys' fees are ten per cent of the sums so collected.[4]

But, as has already been intimated, these attempts to repair the damage after it has occurred can at best be regarded merely as poor makeshifts, and this is true for a number of reasons. In the first place, the relief afforded the stricken persons is wholly inadequate and quite out of proportion with the injury suffered. Quoting again from *Charities and Commons*, it was estimated that the loss for a dozen selected typical cases of permanent disablement amounted to $123,065, while the total compensation reached only the extremely meagre figure of $520. It should perhaps be explained that this estimate is based upon the consideration of the earnings and normal expectation of life of the man struck down. But apart from this disparity in the losses in the compensation, there is sound logic in the old saying that "Prevention is better than cure." Indeed, the very word "cure" implies a double loss; first, the loss through the evil to be remedied, and, secondly, the loss

4. In addition to these company aids, the United Mine Workers of America made payments of $150 each to the dependents of about 230 men within the month following the disaster, and by May, 1910, there was over a quarter-million dollars,—$100,000 especially appropriated by the Illinois legislature, $70,000 contributed by the United Mine Workers of America, and $90,000 remaining of the Red Cross fund to be administered for the permanent relief of the dependents.

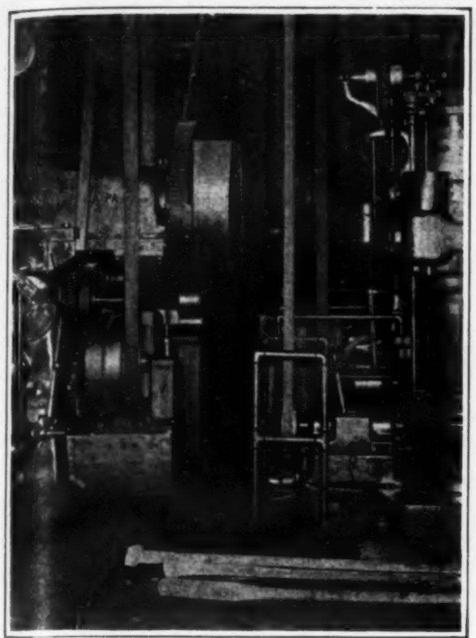


Fig. 3.—Shield for Gear Wheels and Pipe Guard in Narrow Passage.

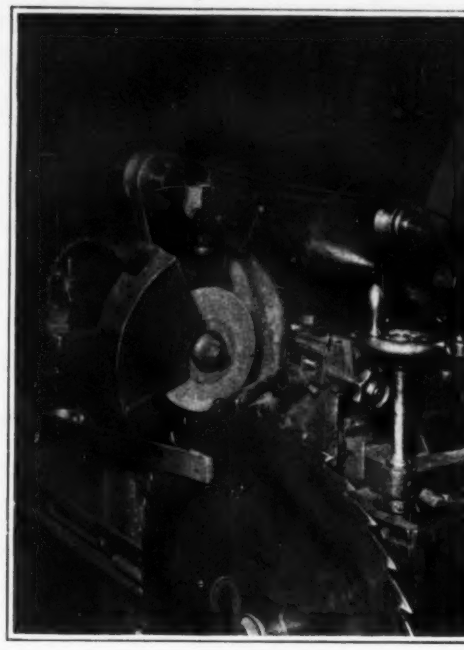


Fig. 4.—Shield Over Emery Wheel for Sharpening Circular Saws.

Fig. 5.—Cutting Off Rivet Heads. The Use of Worn Tools Endangers the Men and is Prohibited.

for the cost of the remedy applied, and, as has already been pointed out, it is contrary to common sense and to higher ideals that a man should unnecessarily be made dependent upon more or less definitely charitable contributions where, in many cases, suitable preventive measures would at one stroke relieve the community of the necessity of taking on itself the burden, and the individual of the need of accepting assistance.

We thus come to the conclusion that the most important phase of the whole subject here touched upon is that of *accident prevention*, and it is most gratifying to record the fact that a great deal is being done in this direction, especially by some of the large firms who apply the same systematic methods in this direction which we find them adopting in the general management of their affairs.

Through the courtesy of the Pennsylvania Railroad, we are enabled to cite a number of facts and figures and to reproduce photographs to illustrate the situation. It is true that the successes recorded by this company can hardly be taken as quite representative, inasmuch as they have earned the medal of the American Museum of Safety, awarded to the American employer who, in the estimation of the museum, did the most during the past year for the protection of the lives and limbs of its workmen by means of safety devices for dangerous machines and processes. But while the figures which we shall presently quote must be construed in this light as an exceptional performance, and therefore perhaps may lack the quality of being entirely typical, they have the advantage of serving as a model and example for other industrial corporations to study.

During the past year the Pennsylvania Railroad has reduced industrial accidents in its shops from 8.7 per thousand employees to 3.7 per thousand. It is understood that the term "industrial accident" means any accident resulting from the use of machinery, ranging from a slight damage to a fatal injury. In 1910 the Pennsylvania Railroad began a rigorous campaign of education among its employees, with the conviction that many broken limbs, crushed fingers, countless contusions and other injuries resulting from accidents were unnecessary and readily avoidable. At the same time experts were employed to inspect the larger shops, that they might show the company where safety devices could be installed to reduce the chances of accident. Motive power inspectors of the railroad accompanied the experts in the inspections.

The benefits resulting from this inspection were so marked that making industrial inspections of shops has become a fixed policy with this railroad. Since the adoption of this plan sixty-six shops have been inspected. Reports were made to the general manager, and practically all of the recommendations offered have been adopted.

The following figures show how the Pennsylvania, from interests of humanity and self, has accomplished results:

Month	Number of Shop Employees	Killed	Serious injuries per 1,000 Employees
January	34,127	4	8.7
February	34,171	7	7.3
March	32,899	0	8.3
April	31,380	1	6.0
May	34,694	3	7.9
June	34,601	1	5.2
July	31,641	2	4.7
August	32,512	2	3.4
September	32,932	0	3.4
October	33,462	0	3.2
November	33,997	2	3.5

The railroad rightly reflects that these results were accomplished on a most economical basis. The reports resulting from inspections contained in all 3,126 recommendations covering improvements or changes in 3,737 tools or machines, at an estimated cost of $35,000, or an average of $530 for each shop. In many cases the expense did not even run up to this figure. At one shop, for which 238 recommendations were made, 157 covered improvements made with practically no cost.

Shopmen themselves have most at stake in the accidents, and the organization of shop safety committees of the rank and file has proved invaluable. As the railroad states: "The prevention of industrial accidents depends largely on the care exercised by the individual workman. By serving on the safety committees they become interested in precautions and will instinctively avoid many of the common and preventable dangers."

A terminal division committee is composed of a locomotive inspector, a brakeman, baggage porter, track foreman, yard foreman, usher, and relief assistant trainmaster.

A road and yard committee is composed of a passenger engineman, freight conductor, inspector of car repairs, telegraph operator and a laborer.

These are standing committees, the members of which are changed from time to time. The recommendations they make are simple and cover a wide range of subjects, such as criticisms of a somewhat general character referring to recommendations for coaming strips for shop elevators, stairways and floor openings, protection for exposed gears, band saws, exposed set screws, safeguarding of all belts and pulleys, conduit for wires from rheostat boxes, protection for counterweight chains, boxing of weights and installation of guard rails at points where workmen may be exposed to belting or moving machinery.

The Pennsylvania Railroad announces that its efforts to reduce industrial accidents will be redoubled in the present year. In accepting the medal by the American Museum of Safety, the vice-president of that company said that the great value of the medal his company received for what it did in 1911 to protect its employees lay in the incentive to its officers and employees to still further achievement.

Our illustrations show interesting examples of what is being done. The frontispiece of this issue shows a band saw at work. It will be seen that the portion of the saw with which the operator's head is in danger of coming in contact is inclosed in a wooden grille work. This precaution is so simple and obviously effective that one wonders any machine of this kind should ever have been without it.

A typical example of a common state of affairs is shown in Fig. 1, which shows a narrow passageway leading the workman past the gear wheels at the end of a lathe. There is every opportunity here for a gruesome accident. One of our engravings, Fig. 2, shows the same spot with a proper protecting hood placed over the dangerous gear. A somewhat similar protecting case for a gear wheel and a pipe rail guard around a pulley at a narrow passageway past the engines of a shop are shown in Fig. 3. Pipe guard rails generally should be used wherever moving parts are apt to catch the clothing or limbs of a passing workman, such as, for instance, in the corner of the engine room shown in Fig. 6, where a flywheel and some electric motors are thus fenced off.

Another example of suitable guards for moving ma-

Fig. 6.—Pipe Guard Railing Around Electric Motor and Fly Wheel.

chinery is seen in Fig. 4, which shows an emery wheel used in sharpening circular saws. A shield is here provided by the safety committee of the Pennsylvania Railroad Company to catch sparks and flying pieces of the emery wheel. The guard also protects employees from injury while placing finished saws in the racks.

It is not, however, only machines which require attention in this matter of preventing accidents to workmen. It is necessary to go into further detail and to attend also to the proper care of the tools employed by the men. Badly worn hammers and chisels and other tools are very apt to lead to injury by either breaking or slipping. One of our engravings, Fig. 5, shows two men engaged in the operation of cutting off bolt heads in the locomotive repair shops. It is just in this kind of work that proper attention to the condition of the tools is a matter of considerable importance.

The examples here cited and illustrated are merely a small selection from among a practically unlimited variety of opportunities which present themselves to the engineer and manufacturer for reducing the cost in human life and limb of the great industrial undertakings which form the characteristic feature of our time.

Thus, in the issue of January 27th, 1912, of the Scientific American, we had occasion to describe in detail the successful work of the Norton Company of Worcester, Mass., manufacturers of grinding wheels, who were awarded last year's Scientific American medal "for devices for conserving human life and limb." A facsimile of this medal forms the central headpiece over this article. It is awarded annually, in accordance with the recommendations of a jury under the auspices of the American Museum of Safety, in recognition of signal advances made in the "great work of safeguarding the American workman from the hazards of his occupation." There is perhaps no movement in industrial affairs which calls for heartier endorsement on the part of the publishers and readers of the Scientific American.

Aviation in the Sahara

Protection of the Motor Against Dust

By M. P. James, C.E.

The attention, not only of military men, but of the entire civilized world has of late been concentrated on conditions of warfare in Northern Africa. Peculiar interest attaches to the use of the aeroplane in this region, since specific problems arise owing to geographical and climatic conditions.

We present a thoughtful discussion of these problems and a proposed solution of some of them from the pages of "*l'Aerophile*."

We quote the words of Mr. James, the author:

There has been much talk of late concerning the employment of the aeroplane in our African colonies. The question of the practicability of crossing the Sahara has been raised. It is quite certain that a regular aeroplane service between our outposts in the extreme South would greatly facilitate the execution of their tasks, lessening danger and fatigue both in the conveyance of instructions and in distant reconnoitering. Such reconnoitering would be both easy and fruitful of results in a region where concealment is practically impossible save in a few oases easy to explore. And what a moral effect would be exerted on a nomad population, which saw its every movement observed and signaled to posts at a distance of several days' march.

But however useful such interpost service might be, we are of the opinion that it is premature to attempt the crossing of the Sahara, and that this task would be far more difficult than crossing a sea of the same extent.

To be sure, one would be above dry land, and the dangers seem less menacing and less immediate. But this is only apparent. To risk one's life in the desert in such machines as we now possess is to court a death more dreadful, if less swift, than drowning.

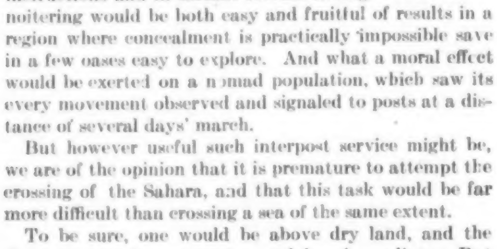


Fig. 2.—Funnel With Strainers on a Horizontal Carbureter.

To traverse the desert would mean going from the south of Algeria to Timbuctoo, from 725 to 1,000 miles, according to the route. I know of no machine at present capable of such a trip without fresh supplies *en route*. The crossing of the Mediterranean, which seems so bristling with difficulties, involves, however, only two laps of 150 miles each, one between Nice and Corsica, and the other between Sardinia and Tunis.

The difficulties encountered in flying above the desert are comparable to those met in flying above water, plus a number of others.

First, there is the impossibility of obtaining new supplies of oil and gasolene for the motor, and of food and drink for the aviator. Second, there is the same difficulty of pilotage. The desert is as uniform and monotonous as the sea. It is ill-charted or uncharted, and the continual displacement of the dunes constantly changes the configuration.

Hitherto, military expeditions and explorations have never adventured without guides, and being on foot have had abundant time and every facility for leisure study of the territory and for the employment of all known means of orientation: a perfectly compensated compass, sextants, and observations of the stars. And native guides have always been found indispensable, just as among mountains.

The officers and explorers who have employed Arab guides report that they have an astonishing instinct of direction, so that they seem at times to possess that famous "sense of orientation" which physiologists have sought to discover in certain animals such as bees and pigeons.

Surrounded by a horizon absolutely naked and uniform to the ordinary eye, and circular as that of midocean, they take without hesitation the path to their goal. They discern the vaguest traces of the passage of a caravan, the vicinity of a well, the approach of a sandstorm. It is very doubtful whether one of these guides, perched in an aeroplane beside the pilot, would retain these qualities.

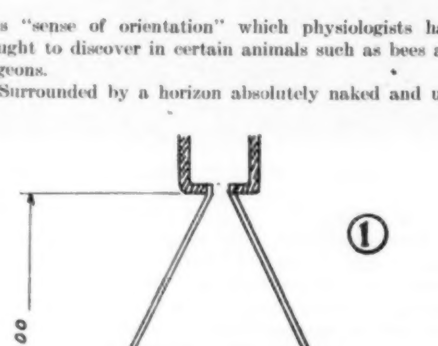


Fig. 1.—Funnel With Strainers on a Vertical Carbureter.

The only serious advantage over the sea offered by the desert is the possibility of descent and prompt ascent in case of stopping of the motor. Even this is merely relative, the latest experiments with Voisin's *Canard* having neatly demonstrated a similar possibility on water. On the other hand, the desert presents many inconveniences that the water is free from.

In the first place, the wind, regular over the sea is very irregular over desert country. This immense surface of heated sand raises the temperature of the air in contact with it, here and there, at points determined by the configuration of the land, ascending columns of hot air are formed, while corresponding descending currents of cold air take their place.

These give rise to gusts and whirlwinds and vertical currents, which, joined with the action of the variations of level and of the dunes (for the desert is mountainous and the plains are covered with dunes), form an agitated and stormy atmosphere most unfavorable for aeroplanes.

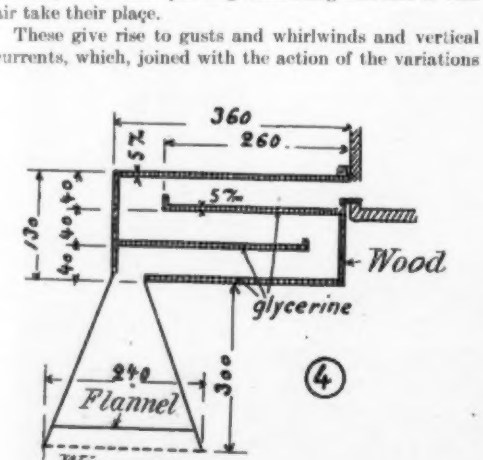


Fig. 4.—Box With Several Partitions Soaked in Glycerine for Collecting Dust From Moist Air.

Finally, these troubled atmospheric conditions often resolve themselves with great speed into a storm of burning sand—a simoon.

The temperature offers a second difficulty. It is improbable that present motors would give good results. Even in our own climate they become overheated on long trips. What would they do under the sun of the desert. Air-cooled motors would "seize" in a quarter of an hour; water-cooled motors would find their radiators transformed into boilers in short order. It will be answered that travel may be by night, but it is necessary to be prepared for unavoidable journeys by day.

But the great obstacle is the dust. This was first shown at the Heliopolis aviation meeting in 1910. The clogging of the carbureters was the great difficulty, and in spite of the shortness of the distance and the alluring prize, no aviator would attempt the Pyramids trip. More recent essays in South Algeria and Senegal have only confirmed this difficulty. However, it is not insurmountable. At the level of the earth the trouble comes from fine sand mingled with dust, blown up in whirls by the wind; at a higher altitude it is sifted dust; at 200 meters (656 feet) altitude this consists of an impalpable powder. But carried up by hot ascending currents, it persists at a much greater height. The example of volcanic dust shows with what facility this powder can be transported by aerial currents. The ashes of Krakatoa encircled the globe seven times after the eruption of 1881. The ashes of Vesuvius have been detected in Iceland. Sounding balloons have proved definitely that desert sand may be found at 2,000 meters height.

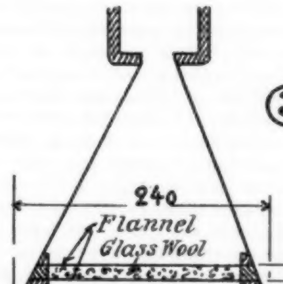


Fig. 3.—Funnel With Glass Wool Strainer for Moist Air.

Hence we cannot avoid dust by seeking altitude. The remedy is to prevent it from getting into the motor. It need not enter by the joints, since they are tight enough to hold oil, and, besides, since they are always greased, they effectively oppose the entrance of dust.

Therefore penetration can occur only in three ways: first, in the aspired air; second, in the exhaust, and third, through the valves.

As for the exhaust, the inconvenience is small, since the particles that can penetrate are no coarser than those which compose the escaping smoke. However, they are more dangerous for the organs of the motor. The latter are composed of carbonized cinders which are not very hard; the dust of the desert, on the contrary is silicious and bites into the working surfaces of the motor, wearing out the piston rings and scoring the cylinders walls, the valves and their seats, as well as bearings. The heating of all surfaces where there is friction is increased, and consequently the chances of seizing. Delicate motors, such as those of rotary type, in which all the organs are exposed to the air, would doubtless behave as badly.

It would be equally prudent to avoid motors having auxiliary exhaust ports in the cylinders at the bottom of the stroke, in which a current of air completes the sweeping out of the burned gases. It would also be well to provide the exhaust ports with pipes. What produces the

detonation is the sudden expansion of the gases striking the outside air; this expansion of gases is followed by a contraction and the exterior air enters the pipe. There is thus a series of oscillations in the course of which the dust can penetrate. It is therefore advisable that the detonation should be produced at the end of a pipe instead of at the exhaust port.

To prevent the dust from entering the valves, water-cooled motors can be entirely enveloped in an aluminium shell with tapering profile, which offers little resistance, certainly less than the motor without this shield.

This shell would be fastened to the crank case by means of a tight joint saturated with oil. For other motors it would be necessary to have a sheath for each group of valves.

But the most important point is to feed the carbureter with dustless air. The only means is to purify the air before it is carbureted. The devices for this purpose must be simple, light, and non-cumbrous. To this end we have experimented with a number of devices which are here described.

The first consists in providing the air entrance of the carbureter with a funnel, as in Fig. 1. Over the bell of the funnel is stretched very fine wire gauze, *a;* then, 25 millimeters back of this, a flannel filter, *b;* finally a paper filter is stretched at *c*. The wire, flannel and paper are fastened to rings of wood screwed into the funnel. The metal gauze stops the larger particles of dust and condenses the humidity, a very important point. The flannel and paper filters complete the operation. It is advisable to place the funnel vertical, with the bell at the bottom, for by striking the funnel now and then, or even by the throbbing of the motor itself, the dust will fall to the bottom. If, for reasons of arrangement or resistance to advance, the funnel must be placed horizontal, it is important to give the frames holding the filters an inclined position, permitting the fall of the dust (Fig. 2).

With these arrangements, which are notably simple, a difficulty occurs when the air is very humid. The moisture is partly condensed on the paper filter, rendering it impermeable to air, so that the aeration of the gas is interfered with. This is why tests were made of the two following modifications: the one in Fig. 3 in which the paper filter is replaced by a mat of mineral wool; and the other in which the paper filter is replaced by the box shown in Fig. 4, a box provided with false partitions, the surfaces of which are moistened with glycerine, a liquid which is always humid, since it absorbs water vapor like sulphuric acid. This arrests the dust which has not been kept back by the flannel. It should be frequently cleaned.

We have tested these devices with an ordinary automobile motor of 35 to 40 horse-power. The carbureter was fed by air holding in suspension very fine dust difficult to remove. We made use of the dust coming from the purification of furnace gases. The dust was collected in centrifugal separators which leave in the air only 0.004 gramme of dust per cubic centimeter, and we considered this as fine and penetrating as that of the desert. It was distributed in the air inside a box by means of a small electric fan. A Claudel carbureter was used. The carburation was not affected, proving that no sensible amount of dust was left in the air.

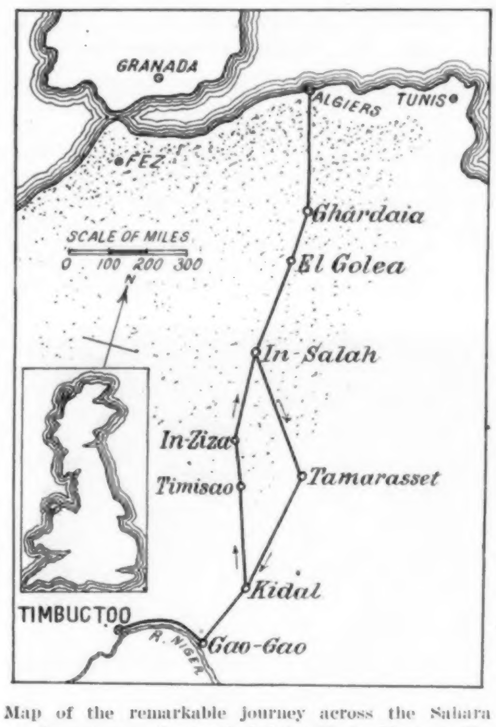
We made several tests, notably 4 of 2 hours each. A first one with the apparatus of Fig. 1; then another in which the air was mixed with water vapor by a bellows-nozzle introduced into the box. This gave air with an excess of humidity never actually reached by the atmosphere, and so impregnated the paper filter as to interfere with the carburation. It is this which led us to construct the apparatus shown in Figs. 3 and 4. However, practice may show that the apparatus in Fig. 1 is sufficient.

Not provided with the separator the motor could not operate in this dusty air more than 4½ minutes at the outside, and then it worked very irregularly.

Our sketches may serve as a basis of departure for those experimenting along similar lines.

Since for the moment, the aeroplane is pre-eminently a military engine, we should be happy to contribute to its introduction into our African colonies, to extend the radius of action while diminishing the fatigues and dangers of our soldiers, the advance guard of our civilization in a remote land.

* * *



Map of the remarkable journey across the Sahara Desert recently concluded by M. le More, a distance of 1,200 miles, occupying about thirteen months. Inset Great Britain is shown to the same scale as the map of Northern Africa.

The mechanical side of the problem is yet the only one which has received serious attention, as will be seen by the following extract from *Flight*.

For the purpose of determining the best route for aeroplanes across the Sahara Desert, a young Frenchman, Mons. le More, has, with two native companions, accomplished a return journey across that barren waste, a distance of nearly 4,000 miles. As a result of his very perilous and arduous trip, which occupied thirteen months, the daring young Frenchman is fully convinced of the possibilities of a trans-Sahara flight, providing that suitable relay stations be arranged. Moreover, he hopes to be the first to perform this journey by aeroplane.

For his journey of exploration he travelled as far as he could by train from Algiers, and then obtained a friendly lift on a wagon to Ghardaia. Then, obtaining a camel and an Arab guide, he started off to cross the desert proper, being joined by another native. Eight days' riding took them to El Golea, where they were given a warm reception by French soldiers. Three days later they reached In-Salah, where they were again kindly received. Accompanied by a French sergeant, they continued on to Tamarasset, and from there to Kidal they journeyed for twenty-nine days without meeting a single human being, while in the ten days spent in getting to Gao there were constant alarms from robber bands, the travellers, however, getting through safely. From Gao to Timbuctoo the journey was by river, and a pleasant variation. After staying at Timbuctoo for three months M. le More visited several parts, and reached Bechar, from whence he returned to Kidal. He started on the return journey across the desert in a different direction, via Timisao and In-Ziza, rejoining his outward route at In-Salah.

Rules Governing the Competition for the $15,000 Flying Machine Prize Offered By Mr. Edwin Gould

1. A prize of $15,000 has been offered by Mr. Edwin Gould for the most perfect and practicable heavier-than-air flying machine, designed and demonstrated in this country, and equipped with two or more complete power plants (separate motors and propellers), so connected that any power plant may be operated independently, or that they may be used together.

CONDITIONS OF ENTRY.

2. Competitors for the prize must file with the Contest Committee complete drawings and specifications of their machines, in which the arrangement of the engines and propellers is clearly shown, with the mechanism for throwing into or out of gear one or all of the engines and propellers. Such entry should be addressed to the Contest Committee of the Gould-Scientific American Prize, 361 Broadway, New York city. Each contestant, in formally entering his machine, must specify its type (monoplane, biplane, helicopter, etc.), give its principal dimensions, the number and sizes of its motors and propellers, its horse-power, fuel-carrying capacity, and the nature of its steering and controlling devices.

3. Entries must be received at the office of the Scientific American on or before June 1st, 1912. Contests will take place July 4th, 1912, and following days. At least two machines must be entered in the contest or the prize will not be awarded.

CONTEST COMMITTEE.

4. The committee will consist of a representative of the Scientific American, a representative of the Aero Club of America, and the representative of some technical institute. This committee shall pass upon the practicability and efficiency of all the machines entered in competition, and they shall also act as judges in determining which machine has made the best flights and complied with the tests upon which the winning of the prize is conditional. The decision of this committee shall be final.

CONDITIONS OF THE TEST.

5. Before making a flight each contestant or his agent must prove to the satisfaction of the Contest Committee that he is able to drive each engine and propeller independently of the other or others, and that he is able to couple up all engines and propellers and drive them in unison. No machine will be allowed to compete unless it can fulfill these requirements to the satisfaction of the Contest Committee. The prize shall not be awarded unless the competitor can demonstrate that he is able to drive his machine in a continuous flight, over a designated course; and for a period of at least one hour he must run with one of his power plant disconnected; also he must drive his engines during said flight alternately and together. Recording tachometers attached to the motors can probably be used to prove such performance.

In the judging of the performances of the various machines, the questions of stability, ease of control and safety will also be taken into consideration by the judges. The machine best fulfilling these conditions shall be awarded the prize.

6. All heavier-than-air machines of any type whatever—aeroplanes, helicopters, ornithopters, etc.—shall be entitled to compete for the prize, but all machines carrying a balloon or gas-containing envelope for purposes of support are excluded from the competition.

7. The flights will be made under reasonable conditions of weather. The judges will, at their discretion, order the flights to begin at any time they may see fit, provided they consider the weather conditions sufficiently favorable.

8. No entry fee will be charged, but the contestant must pay for the transportation of his machine to and from the field of trial.

9. The place of holding the trial shall be determined by the Contest Committee, and the location of such place of trial shall be announced about June 1st, 1912.

10. Mr. Edwin Gould, Munn & Co., Inc., publishers of the Scientific American, and the judges who will be selected to pass upon machines are not to be held responsible for any accident which may occur in storing or demonstrating the machines on the testing ground.

Pulleys and Belting

It is often loosely said, when speaking of the behavior of belting, that "a belt will always run to the high side of the pulley." Without concise definition the term "high side" is a meaningless expression. "A belt running over a pulley," says *Power*, "will always tend to move laterally toward that portion of the pulley face with which it first comes in contact, regardless of the contour of the face of the pulley, its alinement or that of the shaft. It is the direction of the belt going onto the pulley that decides how it will run and not the direction in which it leaves. Shafts are parallel when their center lines are the same distance apart throughout their length. Pulleys on parallel shafts are in line when a line joining the middle of their faces is square with the shafts, and when on shafts not in the same plane they are in line if a line from the middle of the face of the pulley where the belt leaves falls on the middle of the face of the receiving pulley at right angles with its axis. Both pulleys and shafts may be so far out of line as to wholly overcome the tendency of the belt to move toward the portion of the pulley first touched, but this fact does not destroy the tendency. It overcomes it.

"If a pulley has a crowned face, the middle of the crown is the portion first to come in contact with the belt and it will tend to keep it running on the middle of the pulley face, which is in this case the high side. Where it has a straight face and is much wider than the belt, the belt will run equally well on any part of the pulley face if the shaft is in line. If the shaft is out of line, that portion of the pulley rim which is farthest from the other shaft is the high side, but the belt will run away from this side toward the other or low side because the first contact is on this part of the pulley face and the belt must move toward it.

The behavior of a belt running on a pulley is identical with that of a beam moving on rolls.

"If the beam is square with the rolls it will move only in the direction of its length. If, however, one of the rolls is at an angle with the beam it will in turning move sidewise as well as forward and the lateral movement will be toward the end of the roll where the first contact comes and which, if the roll were a pulley and the beam a belt, would be the low side.

"It is the direction in which the belt goes onto the pulley that determines its behavior. The direction of leaving is a matter of no consequence whatever. It is this that makes the running of crossed, quarter-turn and any angle belts possible. So long as a belt goes onto a pulley at right angles to its axis it will run satisfactorily, regardless of high or low sides."

Fig. 1.—Cubical Frames Used in Studying the Early Stages in Plant Development.

The Influence of Light on Vegetation

The Most Favorable Conditions for Growth at Different Periods of a Plant's Life

By Dr. Alfred Gradenwitz

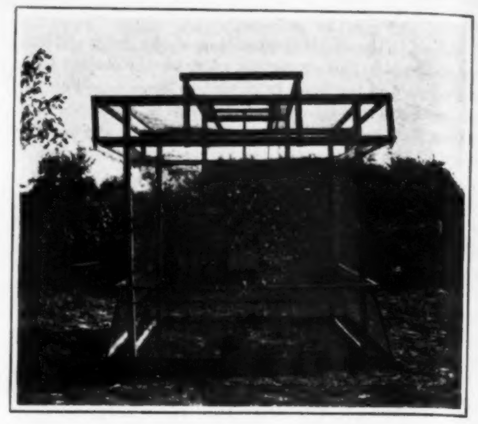


Fig. 2.—Large Cage Used in Studying the Later Stages Up to the Maturing of the Fruit.

While certain inferior organisms are able to develop in perfect darkness, all plants which contain chlorophyll and derive from the air the carbonic acid necessary for building up their carbon compounds, require a certain amount of light for their maintenance and growth. Furthermore, luminous energy plays an important part also in connection with the growth and formation of the most varied organs, not only in green plants but generally speaking in all representatives of the vegetable kingdom.

Fig. 3.—General View Showing Four Large and Four Small Cages of the Type Illustrated in Fig. 2.

Though many experimenters have investigated these phenomena, no accurate data as to the luminous intensity most advantageous for furthering growth during the various stages of evolution of a plant have hitherto been available.

Dr. Raoul Combes, at Paris, has recently published the results of comprehensive researches on this subject, in which the conditions obtaining in actual practice were faithfully imitated so that his work must be regarded as of paramount practical importance. All the plants under test were cultivated in the open, their illumination being controlled by special screens which allowed free access to the wind. Instead of absorbing substances which are very apt to alter the character of luminous radiation, metal gauze screens of graded mesh were used to intercept a part of the sun's rays.

Three different arrangements were used for grading the illumination, the first two being employed in studying the early stages of evolution, whereas the third allowed investigation to the final stages of vegetable life.

The first arrangement (Fig. 1) consists of a series of cube-shaped wooden frames of 39 inches edge. Five faces of each cube are made of metal gauze, while the sixth face is formed by the ground. Each of the cubes is spanned with a different kind of metal gauze. A perforated sprinkling pipe traverses horizontally the set of four cubical frames at about half their height, one end of this pipe being closed while the other communicates with the water mains. Under each of these frames are placed on a slanting board, three cups covered with inverted bowls of slightly larger dimensions. A similar set of three cups, exposed to the open light, is watered simultaneously with the others by the perforated metal tube. A third set of cups is exposed to a continuous water spray in a hermetically closed dark chamber.

The seeds to be investigated are sown on moist cotton-wool placed in the cups described. The seeds in the several frames develop in an atmosphere saturated with water at the same temperature, so that the conditions of growth, apart from differences in illumination, are identical for all.

In the second arrangement the seeds are placed on moist cotton-wool inserted in wide glass tubes. The walls of these tubes are protected against light by a variable number of sheets of parchment, white paper or black paper, thus furnishing six different gradations of light in as many different tubes. These six tubes are placed in a room in front of a window which never receives the direct rays of the sun, thus keeping the temperature and moisture constant in all of them.

The third arrangement, used in investigating plants up to the point of ripeness of the fruit, is shown in Fig. 2. The light is graded in five different steps by metal gauze screens similar to those used in the first arrangement. Five tents, 7 feet 2 inches in height, are used, consisting of a cubical wooden frame over which the metal gauze is so stretched as to leave a height of 15 inches free at the top and bottom in the faces of the cube. The lower uncovered portion is protected by slanting metal gauze walls, leaving ample space between them and the cubical frame. The chamber thus formed is closed above by a metal-gauze screen, all but for a central portion about 3 feet in width, over which a separate screen-roof rises.

This complicated arrangement was chosen with a view to allowing a ready circulation of air in all directions, thus keeping the moisture and temperature permanently similar to those of the outside air. In Fig. 3 is represented a set of four large and four small tents of this kind.

The plants which were used in these tests can be divided into three classes according as they grow in nature under a very slight, moderate or very strong illumination. Tests were made with five grades of light and also in perfect darkness, at five different stages in the evolution of the plant.

Whereas the optimum of light (that is the most advantageous luminous intensity) in the case of wheat has thus been found to be the same for all stages of evolution, *Raphanus sativus*, the common radish, shows different optima according to the stage of evolution. This is brought out in Fig. 4 of our illustrations, in which the Roman numerals indicate successive life-stages and the Arabic numerals denote the degree of illumination in ascending order.

A number of interesting conclusions are derived from these experiments:

The optimum of light varies not only according to the stage of evolution but to the particular part or feature of the plant by which our estimate is made. In practice of course we are usually interested in certain special parts, such as the fruit, or the root, the wood, the bark or what not.

Whereas a feeble illumination or perfect darkness is often found to be seemingly advantageous at the beginning of growth, conditions are reversed in later stages.

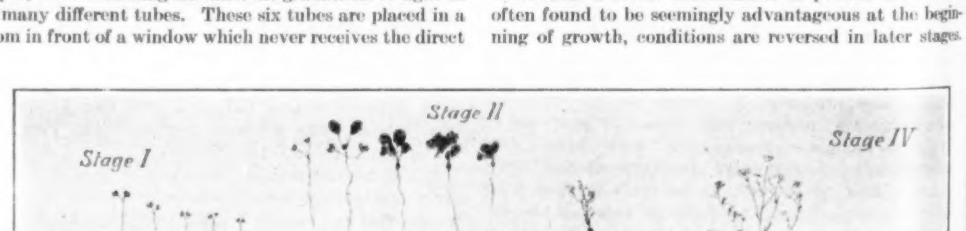


Fig. 4.—Chart Showing the Influence of Illumination Upon the Growth of the Common Radish (*Raphanus Sativus*) at Successive Stages in Its Life Cycle. The numerals 1, 2, 3, 4, 5 Refer to Increasing Degrees of Illumination. Note That at Different Life Stages the Optimum Growth Occurs With Different Degrees of Illumination.

Again, the action of bright sunlight varies between extremes according as the plant naturally grows in the shade or in the light.

Another interesting result is that as the percentage of water contained in the vegetable tissues is the higher, the fainter has been the light in which the plant grows. This water is unequally distributed over the different parts of the plant: In the case of species growing in the shade, the roots are found to contain relatively less water than the parts exposed to air, whereas in most other species the roots at the beginning of growth contain more water.

Futhermore, the stem is found to be the thicker and the more branching as illumination is stronger. Underground organs of reserve, such as the tubercles of the radish and potato, grow to greater abundance the brighter the illumination. The intensity of bloom as well as the quantity of fruit and the rate of ripening reach a maximum in the case of plants exposed to direct sunshine.

A valuable conclusion from a practical point of view is that those plants whose optimum of light varies considerably according to the stage in their life-cycle, will adapt themselves much better to variable conditions of light, and accordingly are far easier to acclimatize than those species in which this figure remains practically constant. Whereas, a strong illumination, in accordance with the above, stimulates the growth of reserve organs, a feeble illumination inversely furthers the utilization of nutritive substance, thus accelerating the growth of the external organs such as the stem and leaves. The lighting of a hothouse should accordingly be adjusted differently according as the leaves or the fruit are the principal product desired.

The above experiments are being continued on a number of other species of the shade-loving type with a view to amplifying and generalizing the practical conclusions arrived at up to the present.

Pictorial Art Among the Bushmen

Extraordinary Skill of an Extremely Primitive Tribe

It requires no deep study of the history of fine and useful arts to convince even the casual observer that the development of these two phases of civilization is in considerable measure independent; thus among the ancient Greeks art, poetry and literature had advanced to a stage which in the estimation of some has hardly ever been surpassed, while, of course, in our industries and applied science we have reached a point vastly superior to anything ever dreamed of by the ancients, however wonderful some of their achievements may seem to us now, when judged with due allowance for our advantage in point of time. The fact is that a nation may be highly cultured and possess a strongly developed artistic sense, without necessarily enjoying the advantages and luxuries which a perfected system of industrial activity provide. And conversely, there are indications to-day, that a people may rise to wonderful attainments in "practical" pursuits, and be somewhat lacking in the appreciation of the finer products of civilization. We will not here enter into any discussion as to which of these two conditions may be preferable; no doubt the ideal to be aimed at is a state in which the two aspects of civilization, the æsthetic and the practical, are developed in well-balanced harmony.

What is true with respect to highly civilized humanity is true also of primitive peoples. The study of archæology and ethnology shows us that remarkable artistic faculties are sometimes displayed among aboriginal tribes, who, in point of industrial development, have risen but little above the animals. Some wonderful illustrations of this are cited by Dr. R. Stube in a recent issue of *Reclams Universum*, from which we reproduce here a number of illustrations. These drawings represent the work of African Bushmen, an extremely primitive tribe, whose state of civilization may be gathered from the fact that even so elementary an industry as that of pottery is unknown to them. Their weapons consist of a small bow with poisoned arrows. For skinning and cutting their prey, they use sharp edged flint. Practically the only tool they possess is a stick weighted at one end and used by the women to dig up roots.

Yet these people produce some of the most remarkable of all primitive sketches known to us. A very interesting example of their work is the group of ostriches seen in Fig. 1. The skill with which the herd of five ostriches is caught by the artist in the act of discovering the ruse of the hunter, who approaches them in the guise of an ostrich, is quite remarkable, and if we were not told of the origin of this sketch we would hardly have thought of crediting it to one of the most lowly of existing tribes of men. Another excellent production is shown in Fig. 3. A band of men is shown in pursuit of some cattle thieves, the majority of whom have turned back to repel the attack of the approaching enemy, while the remainder is occupied in urging on the cattle. Apparently the small figures in gray represent Bushmen, while the tall athletic-looking pursuers are Kaffirs.

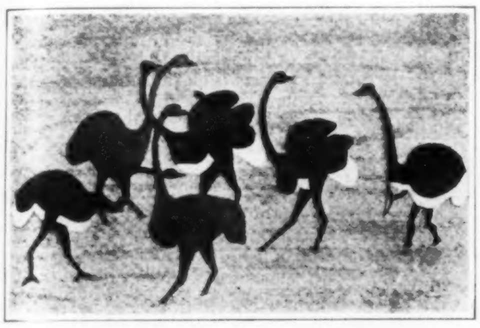


Fig. 1.—Ostrich Hunter's Ruse.

Fig. 2.—In Pursuit of Antelopes.

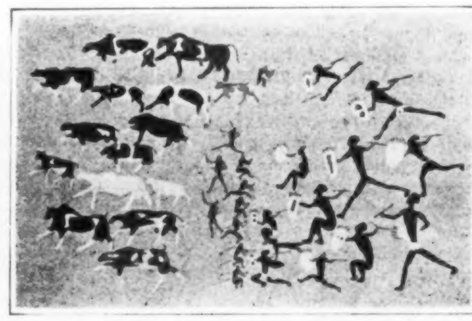


Fig. 3.—Cattle Thieves Caught Red-handed.

In another of our illustrations (Fig. 2) a number of hunters are shown in rapid pursuit of antelopes, and incidentally it will be observed that the antelopes are depicted with a good deal more success than the forms of the men. The action is remarkably well caught, although there is a certain exaggeration which produces an almost ludicrous effect.

A group representing a battle scene is shown in Fig. 4. This is very remarkable and repays some careful scrutiny. It will be seen that a variety of different episodes in battle are depicted. On the right-hand side two men are engaged in a hand-to-hand fight with clubs. At the top in the center a man with a spear is attacking another, who protects himself with a shield. A little to the left of the center, below, is a group of three men, of which one is apparently a captive, being drawn along by the other two. Here again the action is quite remarkable, and some of the figures are drawn with a skill which is surprising in men belonging to one of the lowest types known.

It is difficult to reconcile in one's mind these very clever art productions with the extremely low grade of civilization of the artists, and the question naturally arises whether, perhaps, we have here an example of some art handed down from previous generations, who were placed under more favorable circumstances than the present people. There is, indeed, a certain similarity between the work of these Bushmen and Egyptian art. In both cases a characteristic feature is the presentation of scenes of action taken from the life of the people. But this similarity is probably accidental; there is, it would seem, no inherent connection. We have, in fact, practically nothing to guide us in forming any idea of the origin of the Bushmen's art, and it is to be feared that the tribe will die out before there has been much opportunity to make a more extended study of it.

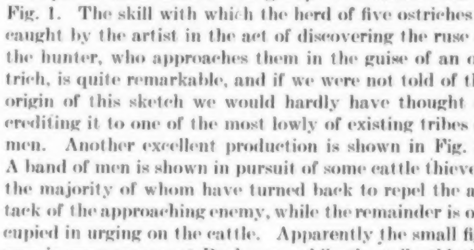


Fig. 4.—A Battle Scene.

Antecedents of the Fireless Cooker

The first definite mention of the fact that food could be cooked without continual heating is said to have been made by the great chemist Justus von Liebig, in the year 1847, although Juvenil, the Roman poet, informs us that the basket which constituted the sole house furniture of the poor Jewish beggar woman of Rome was filled with hay for the purpose of keeping warm the bits of food which were given to the beggars.

The action of a fireless cooker depends upon the fact that a non-conductor of heat surrounding a cooking vessel prevents loss of heat from any material which is put into the vessel in a hot condition, so that the material to be cooked remains for a long time at a high temperature and becomes "done" without further heating. In the case where a certain food requires an average time of four hours' cooking it is only required of a fireless cooker that it retain sufficient heat for that length of time without allowing the temperature to fall below 70 deg. Cent.

Sixty years ago the peasants of Baden were accustomed to the use of the so-called hay box, a simple box provided with a lid and filled with straw, in which the farmers placed hot food in the morning for their dinner in the harvest fields at noon.

In certain other European districts one will occasionally find the practice of wrapping cooked food in cloth and placing it in the still warm bed to remain until the next meal time. In the middle of the last century the hay box of the peasants of Baden found its way to Paris, where it underwent various modifications in which other poor conductors of heat were employed in place of hay. At the World's Fair in Paris (1867) there was exhibited a fireless cooker under the name of "Cuisine automatique norvegienne." In this fireless cooker the non-conducting material consisted of cheap Norwegian fur.

The first public manufacturer of fireless cookers was Johann Heinrich Meidenger of Carlsruhe, who made many experiments on the heat conductivity of the walls of ice-boxes. He found that finely chopped hair, wool, hay and shavings were good insulators for the purpose. Meidenger's fireless cookers astonished the German public to a degree which we can scarcely comprehend. The action of an old box in which anyone could within three or four hours cook food without fire was regarded as downright inexplicable.

The first quoted price for fireless cookers was 22.5 francs (about $4.50).

The fireless cooker has been the means of effecting important changes in certain industries of Berlin, notably the cigarette industry, in which both men and women were employed. It was the custom in this industry to allow the women to cease work an hour or so before lunch time in order that they might have an opportunity of preparing a warm meal for their husbands and families, who were frequently co-workers. Employers on hearing of the fireless cooker introduced it to their work people, and by persuading them to adopt it made it possible for the married women workers to remain at work an equal length of time with their husbands, since the workers could bring their lunch with them and have it smoking hot at lunch time.

Certain of the German State railroads have provided certain classes of their employees with fireless cookers in order that they might have warm food without the necessity of leaving their posts.

* Reproduced from *Pure Products*.

Losses of Combined Nitrogen*

An Important Chapter in World-Economics

By John D. Pennock

Before taking up the consideration of the losses of combined nitrogen in organic substances, to which this discussion will be chiefly confined, it may be well to devote a few words to the loss of nitrogen (1) combined in inorganic substances, and (2) the loss of nitrogen in the gaseous form freed from the oxygen of the air.

Of course, the chief source of inorganic nitrogen combined in mineral form as a natural deposit is Chile saltpeter, or nitrate of soda, formed chiefly on the western coast of South America in the province of Tarapaca, Chile.

Because of the naturally restricted confines of this mineral and the comparatively small quantity known to exist (variously estimated, at the existing rate of consumption, to supply the world's demand for from 50 to 75 years), its conservation in every way possible is a matter of exceedingly great importance.

Now, the losses of this mineral, containing 16.4 per cent nitrogen, which is so important to agriculture as well as the arts, may come about (1) in the mining and refining of the impure mineral, called "Caliche," and (2) in the utilization of the refined product.

The "Caliche" (brown) found in the province of Tarapaca is shown by analysis[1] to be of the following composition:

	Per cent
Sodium nitrate	60.97
Sodium iodide	0.73
Sodium chloride	16.85
Sodium sulphate	4.56
Calcium sulphate	1.33
Magnesium sulphate	5.88
Insoluble	4.06
Water	5.64

While as seen above the product as mined in Tarapaca is comparatively rich in nitrate of soda, that mined in the provinces of Pampa de Tamorugal and Atacama contains from 25 per cent to 50 per cent $NaNO_3$.

It is likely that in the process of refining this Caliche, which consists in lixiviating, settling or filtering, evaporation and crystallization, there is a considerable loss of the valuable $NaNO_3$. Just what this loss amounts to, the very meager scientific information available does not enlighten us.

These deposits of nitrate are of vital importance to the world at large and, though they are held by private corporations, principally German, the Chilian government having been forced to retire from the business because of the competition of the private operators, they should be carefully conserved. Further, it might be desirable that an international committee, composed of chemists appointed by the governments of those countries most vitally interested, should visit the nitrate fields, determine what losses exist, if any, study into the present methods of refining the crude product and make recommendations for the improvement of these methods, if found unsatisfactory.

It is difficult to determine how economically the 2,251,000 tons of nitrate of soda shipped from Chile in 1910 was used. Of this, during 1910, 535,820 tons came to the United States and was used in the arts as follows:

	Per cent
In manufacture of fertilizers	13
In manufacture of dyestuffs	12
In general chemistry	10
In glass	4
In explosives	41
In nitric acid	9
In sulphuric acid	6
Unaccounted for	5

Most of the nitrate used in dyestuffs and explosives passes through the form of nitric acid. In the manufacture of nitric acid by the ordinary method, 90 to 93 per cent of the nitrogen of the nitrate is converted into nitric acid; the yield may be increased and the loss of combined nitrogen from this source reduced by the use of the Valentiner vacuum process which brings the yield to 97 or 98 per cent.

Pure Nitrogen.

In the early days of the manufacture of calcium cyanamide, the nitrogen necessary for the treatment of the carbide was obtained by separating nitrogen from liquid air; later the oxygen of the air was removed by passing the air over heated copper, the oxide being subsequently reduced by heating with natural gas (at Niagara Falls).

The waste gases of the precipitating towers of an ammonia soda process furnishes an abundant supply (2,940 tons per day in this country) of nitrogen which would be suitable for the manufacture of cyanamide. The oxygen of the air used to burn the coke in the lime kilns is completely converted to CO_2, so that the gas going to the precipitating towers contains only CO_2 and N, and when leaving the tower is practically pure nitrogen, there being one to two per cent of CO_2 which could be readily absorbed by passing the gas through milk of lime. A cyanamide plant, however, is preferably located where there is cheap power and hence cannot utilize the cheap nitrogen from an ammonia soda works.

Losses of the Combined Nitrogen in Organic Substances.

The losses of the nitrogen contained in inorganic substances is unimportant compared with the losses which daily occur to the extent of hundreds of tons from the improper use of the organic substances which contain it. Further, there are many organic substances containing such high percentages of nitrogen, which at present go to waste or lie in the earth unutilized, which would produce so high a yield of ammonia that the dry distillation for ammonia alone would be very profitable. Among these substance may be mentioned shale, peat, garbage after the removal of the oils and fats, and sewage sludge. These products will yield on distillation 75 to 85 pounds of ammonium sulphate per ton, or three times as much as coal.

Of all the losses of combined nitrogen, that which goes to waste in the manufacture of coke by the beehive process is the greatest.

In the conferences on the conservation of mineral resources inaugurated by ex-President Roosevelt a few years ago, the great loss of fuel[1] and valuable nitrogen in the beehive method of coke-making occupied a prominent part in the discussions.

James Douglas,[2] in a paper on "Conservation of Natural Resources," deplored the loss of coal and valuable by-products but stated that the development of by-product ovens could not rapidly proceed to displace the beehive ovens because chemical industry was unable to assimilate and utilize the by-products with suitable returns.

Since 1893, when the first by-product coke oven was built at Syracuse, and it was demonstrated that retort coke was equal in quality to that made in the beehive oven and the by-products, tar, ammonia, benzole and cyanides, could be recovered in sufficient quantity to make the operation a profitable one, there has been no justification for the construction of additional beehive ovens.

It is perhaps true that that particular chemical industry which converts benzole and other coal tar products into colors and refined chemicals is pretty effectually fixed in the hands of Germans and not easily wrested from them, and they may continue to ship to this country \$7,000,000 worth of colors, but the consumption of sulphate of ammonia for fertilizers is increasing at such a rate that the United States production cannot supply the demand and nearly as much is imported as is made in this country. Further, the price is higher than it has been for several years. The same may be said of the price of tar. New uses for tar have been found so that the price has not fallen appreciably in the last ten years, in spite of the fact that the annual production has increased enormously.

To what extent losses of combined nitrogen have occurred since 1893, when the retort coke ovens were introduced and the loss could have been avoided, a glance at the coke statistics will show. From 1893 to 1910 inclusive the coal coked in beehive ovens, where the volatile nitrogen was ruthlessly wasted in fire, amounted to about 810,000,000 tons. Had this been coked in by-product ovens, the volatile nitrogen of the coal would have yielded 23 pounds of ammonium sulphate per ton, or a total of 9,315,000 tons, which at \$60 per ton would have had a value of \$558,900,000. But this would not be all. Had this ammonia been recovered, it would have been used on the soil as a fertilizer, the crops would have been increased fully 20 per cent and the saving would have been many millions more.

Percentage of Pure Nitrogen Evolved and Recovered.

In the various Semet-Solvay plants throughout this country the nitrogen content of the coals varies from 1.2 to 1.45 per cent. The evolved nitrogen amounts to about 33 per cent of the total contained in the coal.

Taking the results of the distillation at one of these plants, we have the distribution of the nitrogen as follows:

[The nitrogen in all cases is figured to $(NH_4)_2SO_4$.]

	Lbs. $(NH_4)_2SO_4$ per Ton Coal	
Coal, 1.3 per cent nitrogen figured to sulphate.		122.6
Ammonia yield, actual sulphate	25.0	
Nitrogen left in coke, as sulphate	78.2	
Nitrogen left in 10.000 cu. ft. gas as sulphate	12.0	
Nitrogen in tar (90 lbs. per ton) as sulphate	3.5	
Nitrogen in pyridine	0.3	
Nitrogen in cyanides	0.4	119.4
Unaccounted for		3.2

Thus the nitrogen in the coal is distributed as follows:

	Per cent.
Recovered as ammonia	20.3
Remaining in the coke	63.7
As elementary nitrogen in gas	8.1
In tar	2.9
As pyridine	0.25
As cyanide	0.3

Attempts have been made to increase the amount of nitrogen converted to ammonia. In cases where the ash of the coal is low, it is permissible to add lime, which must be very intimately mixed in a state of powder. The ammonia yield is increased from 10 to 15 per cent. If the walls of the ovens are laid up with silica brick, the lime in the coal is likely to flux with the brick and the coke will stick to the walls.

The result of a trial for five months[1] of adding 2 per cent lime to coal carbonized in a gas works at Cheltenham, England, was an increase of 1.88 pounds sulphate of ammonia per ton. There was an additional advantage of reducing the sulphur in the gas from 40 to 21.5 grains per 100 cubic feet.

Metallic Oxides Reduce Ammonia Yield.

At one of the plants located near a blast furnace which received its supply of coke from the by-product ovens, the fine iron oxide flue dust was mixed with the coal being charged to the ovens, thinking thus to save it from the dump heap, but the effect of 3 per cent of oxide introduced caused the NH_3 yield to fall off 8 per cent.

Other Ways of Saving Nitrogen of Coal.

Hundreds of thousands of tons of coal per annum are converted into producer gas in the Mond producers in England, steam being used to blow the producers and to maintain a low temperature. The gases are washed with acid and 80 pounds of ammonium sulphate are obtained per ton of coal, four times as much as would be obtained from the same coal in a retort coke oven.

The ultimate solution of the problem of the utilization of peat will probably be the conversion to gas in a producer and the utilization of this gas in gas engines, for the handsome return from the 110 pounds $(NH_4)_2SO_4$ saved per ton will make the proposition very profitable.

On account of the high percentage of oxygen in peat, dry distillation destroys the ammonia, but in the Mond producer, peat containing 50 per cent moisture may be gasified, showing 75 to 80 per cent[2] conversion of the nitrogen of the peat to ammonia: 4,000 cubic meters of gas of 1,400 calories are obtained from one ton of peat and 3 to 6 per cent tar containing 15 per cent of soft paraffin and 50 per cent neutral oils suitable for Diesel motors.

That there is some progress toward substitution of by-product ovens for beehive is shown by the following figures: In 1900 there was total coal coked, 20,533,348 tons. In that year 1,075,727 tons were coked in by-product ovens, or 5 per cent of the total. In 1910, of the total coke made, 41,708,810 tons, 7,138,734 tons were made in by-product ovens, or 17 per cent. This advance is encouraging. What is more encouraging is the fact that the government statistics show that a smaller number of beehive ovens were being built in 1910 than previous years and that of the total ovens, 2,567 building at the end of 1910, 1,200, or 46.75 per cent, were by-product ovens. As the average coking capacity of a by-product oven is four times that of a beehive, it is evident that the additional producing capacity of 1910 was more largely by-product than beehive.

Comparative Advancement in Saving of Combined Nitrogen in Germany, England and the United States.

When Germany began to develop the coal tar color industry she was forced to import her tar from England; the necessity for increasing the supply of tar caused Germany at once to begin abandoning the beehive ovens, substituting retort coke ovens. In 1900, 30 per cent of the coke made in Germany was coked in retort ovens. In 1910, so complete had the transformation to retort ovens taken place that over 80 per cent was made with

* Reproduced from *The Journal of Industrial and Engineering Chemistry*.

1. Machalske, *Am. Fertilizer*, 25, 8,

[1] The easily accessible coals will be exhausted about the year 2027. M. R. Campbell and E. W. Parker, *Am. Inst. Min. Eng.*, 40, 258.

[2] *Am. Inst. Min. Eng.*, 40, 419.

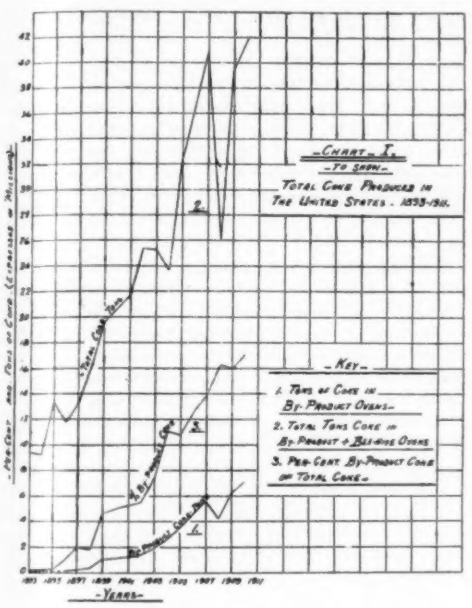
[1] *J. Soc. Chem. Ind.*, 30, 288, 1367.

[2] *Chemiker Zeitung*, May 11, 1911, p. 505.

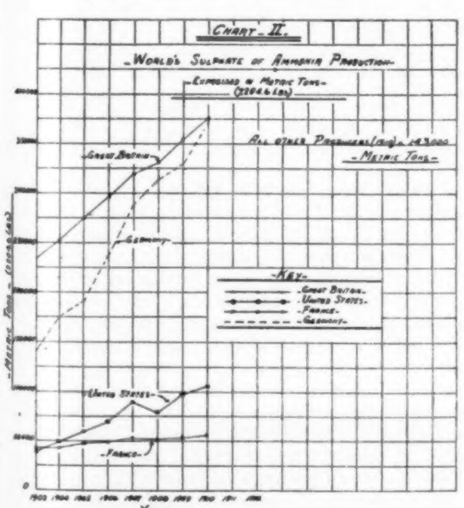
recovery of ammonia and other by-products. Soon all the coal used for coke-making in Germany will be coked with the recovery of by-products. When this time arrives the retort oven will be operated for tar and ammonia as primary products and coke secondary. At such time ammonia from cyanamide or synthetic ammonia will be produced in large quantities as higher prices will make these processes profitable.

England until 1910 has been the greatest producer of sulphate of ammonia. In this year Germany nearly equaled England's production. In 1900, 10 per cent of England's metallurgical coke was made in retort ovens; in 1910 over 18 per cent was so made.

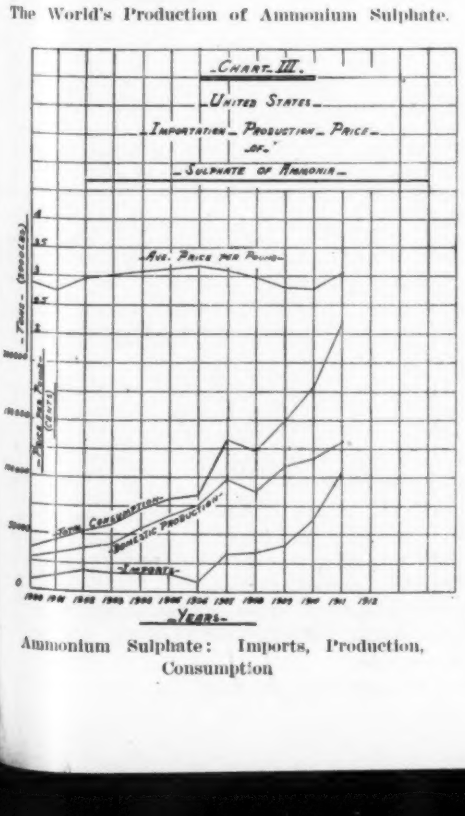
The retort coke output in the United States in 1900 was 5 per cent of the total. In 1910 this had increased to 17 per cent.



Total Coke Production in United States, 1893-1911.



The World's Production of Ammonium Sulphate.



Ammonium Sulphate: Imports, Production, Consumption

Chart I shows the increase in retort coke output year by year.

The relative standing of the four greatest producers of ammonia in the world is shown in Chart II.

Imports, domestic production, and price of ammonium sulphate are given in Chart III.

A steel manufacturer considering the expansion of his iron and steel business runs against these facts in considering by-product ovens: A beehive oven costs about $400 and cokes 2.2 tons of coke a day; a by-product oven cokes 10 tons a day and costs, including by-product apparatus and all equipment for entire operation, $11,000 to $12,000; but in spite of the greater capital invested, he can get his coke at his furnace at the same price and pay interest and depreciation on the larger investment, because of the value of the by-products obtained.

It may be shown that a corporation owning its Connellsville coal lands, and its beehive coke ovens at Connellsville, and blast furnaces and steel mills at Pittsburgh, can well afford to shut down its beehive ovens and make its coke in by-product ovens at Pittsburgh from coal shipped from Connellsville. The corporation would get its coke at the same price, taking into consideration the increased yield of coke in by-product ovens, and reducing the gross cost of the coke by the returns from tar, benzole, and part of the ammonia. In addition to supplying the coke at the same price, there will be a large part of the ammonia yield which would not be required as a credit to bring the price of the by-product coke down to the price of the beehive at Connellsville plus freight to Pittsburgh. The extra amount of ammonia is then a by-product which has cost absolutely nothing.

An important factor in reducing the cost of by-product coke is the much higher yield obtained, as stated above. The yield of Connellsville coke in by-product ovens is 73 per cent, while in beehive ovens it is 66 per cent, or 10.6 per cent greater. Assuming this rate of increase in yield for all coal coked in beehive ovens, it may be shown that the 34,635,000 tons of coke made in beehive ovens from 52,400,000 tons of coal could have been made in by-product ovens with 47,430,000 tons; or 4,970,000 tons would have been saved, would not have been mined; our mines would have been conserved to this extent and the life of the mines so much lengthened.

Further, for a ton of coal coked in by-product ovens there is gas available as fuel in the steel plant amounting to 4,000 to 5,000 cubic feet. This amount of gas is the equivalent in the steel mill of 200 pounds of coal, or, with coal at $1.75, is worth 17.5 cents. There is, therefore, not only a saving in coal used for coking, but there would be a saving in the coal used as fuel. This would amount to 200 pounds for every ton of coal coked in by-product ovens. We have shown above that 47,430,000 tons is the coal required in by-product ovens to take the place of the larger amount coked in 1910 in beehive ovens. Hence, the coal equivalent for the total gas saved would be 4,743,000 tons. This added to the amount of coal saved because of higher yield of coke, we have a total saving of 9,713,000 tons of coal which could have been left in the mine in 1910 and this reduced supply of coke and coal would have been adequate for the demand.

If the Federal Government is serious in its purpose to conserve our coal resources it may do so by ruling that additional coking capacity in the future shall be of the by-product type. The average increase per annum in the past ten years of coke production has been 2,000,000 tons. This increase would be taken care of by the building of 600 modern by-product ovens. If by-product coke is to take the place of anthracite coal for domestic fuel, as in certain places it is rapidly doing, the increase per annum will be more than 2,000,000 tons.

There seems to be among iron manufacturers, who have installed large numbers of by-product ovens, a tendency to have them in sufficient number to supply their minimum demands for coke, while the difference between the minimum and maximum is perhaps more economically supplied by beehive ovens which are a much smaller unit and may be shut down and remain idle and again

Complete List of By-product and Retort Coke-oven Plants in the United States, January 1, 1911.

System.	Plant Location.	Name of Company.	No. of Installments.	Date Put in Operation.	No. of Ovens.	Uses of Coke.	Uses of Surplus Gas.
Semet-Solvay	Ensley, Ala.	Tennessee Coal, Iron and R. R. Co.	First	Oct. 1898	120	Blast furnace	Fuel gas
			Second	Mar. 1902	120		
"	Tuscaloosa, Ala.	Central Iron & Coal Co.	First	Feb. 1906	40	Blast furnace	Fuel gas
"	S. Chicago, Ill.	By-products Coke Corporation	First	Dec. 1905	120	Blast furnace, foundry and domestic.	Illuminating
"			Second	" 1906	40		
			Third	" 1910	40		
"	Delray, Mich.	The Solvay Process Co.	First	Sept. 1901	30	Furnace, foundry, domestic and lime-burning.	Illuminating
			Second	Nov. 1902	30		
			Third	Mar. 1906	60		
			Fourth	" 1909	12		
"	Syracuse, N. Y.	The Solvay Process Co.		Jan. 1893	12	Lime-burning and foundry.	Fuel
			First	" 1896	13		
			Second	" 1900–1903	15		
			Third				
"	Geneva, N. Y.	Empire Coke Co.	First	Aug. 1904	30	Foundry and domestic.	Illuminating
			Second	" 1909	16		
"	Cleveland, O.	Cleveland Furnace Co.	Third	" 1910	49		
"	Dunbar, Pa.	The Dunbar Furnace Co.	First	" 1896	50	Blast furnace.	Fuel gas
			Second	July 1903	60		
"	Chester, Pa.	Philadelphia Suburban Gas and E. Co.	First	April 1904	40	Blast furnace.	Illuminating
"	Lebanon, Pa.	Pennsylvania Steel Co.	First	July 1904	90	Furnace and gas.	Fuel and gas engines
"	Steelton, Pa.	Pennsylvania Steel Co.	First	Jan. 1907	120	Blast furnace.	Fuel gas
"	Benwood, W. Va.	National Tube Co.	First	Oct. 1898	60	Blast furnace.	Fuel gas
			Second	Mar. 1901	60		
"	Milwaukee, Wis.	Milwaukee Coke & Gas Co.	First	" 1904	80	Blast furnace, foundry and domestic.	Illuminating
			Second	" 1906	80		
Koppers	Woodward, Ala.	Woodward Iron Co	First	1910	60 [2]	Blast furnace.	Fuel and power
"	Corey, Ala.	Tennessee Coal, Iron & R. R. Co.	First	1910	280 [2]	Blast furnace.	Fuel and power
"	Joliet, Ill.	Illinois Steel Co.	First	1908	140	Blast furnace.	Fuel and power
			Second	Mar. 1909	140		
"	Gary, Ind.	Illinois Steel Co.	First		560 [2]	Blast furnace.	
United-Otto	Indianapolis, Ind.	Citizens Gas Co.	First	1909	50	Blast furnace and foundry.	Illuminating
"	Sparrows Pt., Md.	Maryland Steel Co.	First	" 1903	200	Blast furnace.	Illuminating
"	Wyandotte, Mich.	Michigan Alkali Co.	First	Oct. 1902	15	Burning limestone.	Fuel gas
			Second	Aug. 1906	15		
"	Duluth, Minn.	Zenith Furnace Co.	First	July 1904	50	Blast furnace.	Illuminating
"	Camden, N. J.	Camden Coke Co.	Second	" 1906	50	Foundry and domestic.	Illuminating
"	Buffalo, N. Y.	Lackawanna Steel Co.	First	May 1904	564 [1]	Blast furnace.	Fuel gas
"	Hamilton, O.	Hamilton Otto Coke Co.	Second	" 1909	50	Blast furnace.	Illuminating and power
"	S. Sharon, Pa.	Carnegie Steel Co.	First	July 1903	212	Blast furnace	Illuminating
"	Johnstown, Pa.	Cambria Steel Co.	Second	Mar. 1899	100	Blast furnace.	Fuel gas and power
			Third	Sept. 1904	100		
			Fourth	Feb. 1907	112		
Otto-Hoffman	Everett, Mass.	New England Gas & Coke Co.	First	June 1899	400	Domestic, industrial and locomotive.	Illuminating and power
"	Camden, N. J.	Camden Coke Co.	First	Jan. 1903	100	Blast furnace.	Illuminating and fuel
"	Hamilton, O.	Hamilton Otto Coke Co.	First	April 1901	50	Domestic and foundry.	Illuminating power
"	Glassport, Pa.	United Coke & Coal Co.	First	Feb 1897	120	Blast furnace and domestic	Illuminating and fuel
"	Johnstown, Pa.	Cambria Steel Co.	First	Nov. 1895	60	Blast furnace	Fuel and power
"	Lebanon, Pa.	Lackawanna Iron & Steel Co.	First	Mar. 1903	232	Blast furnace	Fuel gas
Rothberg	Cleveland, O.	Cleveland Furnace Co.	Second	Oct. 1907	25	Blast furnace	Illuminating and power
"	Buffalo, N. Y.	Lackawanna Iron & Steel Co.			282	Blast furnace	Fuel gas
"	Lebanon, Pa.	Lackawanna Iron & Steel Co.	First	May 1903	5		
Didier	S. Bethlehem, Pa.	Lehigh Coke Co	First	" 1903	300 [2]		

[1] Contracted for; 188 Completed.
[2] Not completed.

started up without excessive loss or deterioration. There are in the United States 100,000 beehive ovens, 47,000 of which have been built in the last ten years. As the life of a beehive oven is supposed to be ten to twelve years, it would appear that a very large number of beehive ovens would soon be useless. Another feature of the by-product coking industry which must not escape consideration, is the increasing tendency of the illuminating gas manufacturers to look with favor upon the by-product coke oven as a valuable substitute for the small gas retort, particularly when the source of heat for cooking this coal is cheap coal in a producer, for when thus operated 10,000 cubic feet of gas is available instead of 4,500. Further, it may ultimately drive out the water gas plant, which now usually exists in illuminating gas plants to furnish 50 per cent of the producing capacity, for its coke is of superior quality to the ordinary gas house coke and may be used for foundry purposes, and if it is sold for such purposes there will be none for the making of water gas.

It is difficult to predict the future of any industry and determine how much longer this devastating beehive coke manufacture will exist and the unnecessary loss of valuable nitrogen continue, but in the face of the crying needs of the soil, which have brought about a world's shortage of available nitrogen in spite of the placing of about 59,000 tons of cyanamide on the market, several thousand tons of Norwegian saltpeter ($CaNO_3$), a small production from the Haber process (N+H), and the very large increase in the world's production of ammonium sulphate, there will certainly be a rapid substitution of the by-product for the beehive oven. It is not unreasonable to expect that the government returns at the completion of this decade will show that 50 per cent of the coke used in this country will come from by-product ovens; certainly the great increase in importation of ammonium sulphate in 1911, from 63,000 to 105,000 tons, 66 per cent, while the domestic production went from 116,000 to 130,000, or an increase of 12 per cent, coupled with the increase of price from 2.8 cents per pound to 3.05 cents would warrant an expansion in the by-product coke industry.

A statement of the condition of the by-product coke industry upon January 1st, 1911, according to Mr. E. W. Parker, is found on the preceding page.

Aeroplane Accidents in France and Germany.—In the fatal accident to Lieut. Ducourneau at Pau on February 23rd, caused by the breaking of the propeller of his Nieuport monoplane when he was 600 feet in the air, the machine plunged into a marsh, while its pilot, who was thrown out in mid air, was found dead some distance from his machine. At Pau on the 2nd ult. Lieut. Pomentonia of the Franch army was killed in an aeroplane accident. At Issy-les-Moulineau, on March 9th, Mrs. Draincourt fell from a great height. Fortunately she managed to partially right her machine before it struck. She was seriously injured. The next day Mlle. Suzanne Bernerd, a young aviatress, but 19 years of age, was killed at Etampes by a fall she sustained when attempting to make a right-hand turn with her biplane. On March 13th at Pau, Lieut. Henri Sevelle fell some 500 feet and was killed when the wing of his Blériot monoplane broke off just as he began a volplane. The lieutenant was practising for his higher military certificate and had been flying for two hours. Another aviator, flying nearby, had a close view of the accident and noticed that it occurred just as Sevelle started to volplane. On March 15th a leading German aviator, Herr Witte, was flying at Teltow, a suburb of Berlin, when his Wright biplane collapsed and fell from a considerable height. Herr Witte was instantly killed. On the 16th ult. Lieut. Bertoletti, while learning to fly a Blériot monoplane at the military aerodrome of Somma Lombarda, fell and was killed. Ten days later a German aviator named Kleine was killed by a fall of 300 feet at Dusseldorf.

Protecting the Hands Against Chemicals.—By coating the hands with a very thin film of wax, complete protection may be afforded them against the action of many chemicals, especially while working with photographic developers. Thus solutions of formaldehyde may be handled freely without fear of contracting cutaneous eruptions. Such a protective film of wax may be obtained in the following manner: One hundred grammes of unfilled curdle soap is dissolved in 100 centimeters of boiling water, into which are stirred 100 grammes of wax. As soon as the latter is melted, 10 cubic centimeters strongest ammonia water are added, and when the mixture becomes quite clear 100 grammes of lanoline (or lard) is mixed in. The whole should then be diluted to honey consistency. Before applying this paste, the hands must be washed with soap and water. They are then lathered once more and a small quantity (about hazel nut size) of the paste is spread out by rubbing, together with the soap and lather, until the hands become completely dry. They are then washed off until every trace of soap is removed, but instead of drying the hands, the adhering water is merely shaken off.—*Pharm. Centralbl.*

Trade Notes and Formulæ

Fluid Soap for Washing Cattle.—A good cattle washing compound is obtained from the following mixture: Creolin and lysol, each 100 parts, and 150 parts of tincture of green soap are mixed. To be diluted with water for use.—*Pharm. Ztg.*

Ink for Writing on Porcelain.—Dissolve on the one hand 20 parts of rosin and the requisite quantity of nigrosin in 150 parts spirits of wine, on the other, 35 parts of borax in 250 parts of water and then mix the two solutions.—*N. Erf. u. Erf.*

Blue-black Stain for Brass by Cold Process.—Thirty parts of precipitated carbonate of copper are dissolved, at room temperature, in 1,000 parts of spirits of sal ammoniac (with 10 per cent of ammonia) by shaking in a stoppered bottle, and preserved in a closed bottle. For use this blue fluid is poured into an open dish and the well-cleaned brass objects freed from oxide, fastened to brass wire, are kept immersed in it for two minutes, moving them to and fro all the time. The articles are then quickly rinsed in water and dried with a soft cloth. The process is repeated once in the manner above described.—*Neuest. Erfindungen und Erfahrungen.*

Salt as a Wood Impregnating Medium.—According to the *Chemiker Ztg.*, a very simple medium has been, for many years, employed in Russia for the preservation of wooden ties and telegraph poles, which is but little known, i.e., impregnation with brine. It was accidentally noted some years ago that the burying of a few pounds of salt alongside a telegraph pole very materially increased its durability. Since then, the method has been systematically practiced, with the aid of brine on the sea coast. In large basins on the Siwaschen Bay the ties and poles are allowed to soak for three to four months, during which the wood absorbs about 70 to 100 per cent of its weight of salt solution.

Blue Stain.—By coating with the following stain, a beautiful dark blue color on wood is obtained: Solutions are made respectively of 100 parts of iron alum in 1,000 parts of water and of 50 parts of red prussiate of potash in 1,000 parts of water which are kept separate in a dark place, in brown bottles. Shortly before use, equal parts of the two solutions are mixed and a small quantity of acetic acid added to the stain. The mixed solution will keep one day. The color is at first green, but in accordance with the character and age of the wood, changes more or less quickly into blue. In the case of ash the change is quickest, with pine, fir and spruce wood, it takes longer. In the case of oak and very resinous, knotty woods, some spots may remain green. To obtain an immediate change to blue of these places, they should be painted with a solution of hydroquinone, or 7 parts of tannic acid in 1,000 parts of water. If a light blue shade is required, or we desire to obtain the blue color at once, the wood must be treated, prior to the above described stain, with a solution of 5 parts hydroquinone in 1,000 parts of water.—*Der Chemisch-Technische Fabrikant.*

Granulating.—The process of granulating is a very diversified one, and must be carried out according to the object we may seek to attain with the aid of the granulated metal particles. As a rule, the granulation of metals is affected by pouring the molten mass from a suitable height slowly into a vessel filled with water, the water being in the meantime kept constantly in motion with the aid of a whisk broom. The metallic granules obtained by this method, however, are of varying size and form. According to another process, we take an iron ball (an old engraver's ball or the like), place it in a suitably large vessel, which we fill to about one-half the height of the ball with water. If the molten metal is now allowed to drop slowly from above on to the center of the ball, it breaks up into small portions, which roll slowly down into the water, thereby acquiring a rounded shape; nevertheless these granules, although round, are still of different sizes. If we want flattened granules, the fluid metal is allowed to fall on to a slanting board, placed under water, which gives us lentil-shaped granules. To effect the last-named purpose, the fluid mass may also be allowed to fall on to a rotating disk, placed under water in a tub, the granules in this case, in lentil form, being thrown from the disk into the space in the tub. In the granulation of solders, etc., it is necessary that the granules, as far as possible, be uniform in size, thereby insuring their melting at the same time. For this purpose, wire sieves of suitable size are used as in shot casting. The metal sieves are filled with small pieces of red hot coal. If the fluid metal is poured over the glowing coals in the sieve, it seeks a passage through the coals, is passed by the metal strands of the sieve in particles of suitable size and falls into the water tank placed under the sieve. By employing the methods described above in conjunction with this, round, flat or irregular shapes may be obtained. *Deutsche Goldschmiede Zeitung.*

Science Notes.

To Increase the Irridescence of Mother of Pearl, the following process is said to be used in the Austrian mother of pearl factories: A large vessel that can be tightly sealed is filled with sufficient water to cover the mother of pearl. Plenty of spirits of sal ammoniac and chloride of silver in powder form are added, until the solution is saturated with it. In this solution the mother of pearl articles are left for about a week, the vessel being well closed and kept in the dark. Then the articles are removed from the fluid and laid, without previous drying, in the sun for about two days. By this means the play of color is said to be very greatly increased.—*Edelmetall Industrie.*

Gilding on Aluminium.—Use as binding medium the following composition: Dry white lead, 25 parts; white lead ground in oil, 25 parts; yellow ochre, 25 parts; English varnish, 25 parts. These substances are pulverized, well mixed together, then applied to the aluminium and dried in the oven at 40 deg. Cent. The first application is rubbed down smooth and a second given in the same manner, which is coated with English brilliant varnish, allowed to dry and again heated to 40 deg. Cent., after this gild with leaf gold. Then polish, dry a third time, cover again with brilliant varnish, and finally polish with tripoli. By this means aluminium articles may be easily and comparatively cheaply gilded.—*La Science Pratique.*

Growing Diamonds Artificially.—It has been found by W. von Bolton that certain carbon compounds, such as illuminating gas, when exposed to the action of mercury vapor, are decomposed, liberating a portion of their carbon partly in the form of amorphous powder and partly in the form of microscopic diamonds. Mr. Bolton has continued his experiments with a view to causing the growth of the small diamonds thus formed. He took very fine diamond powder which, even under the microscope at a magnification of 68 diameters, showed only a few crystals. This powder was placed on a layer of sodium silicate and exposed to mercury vapors proceeding from sodium amalgam. The materials were kept at 100 deg. Cent. and a slow current of illuminating gas was passed through. At the end of one month a very small quantity of black carbon had deposited, while the original layer of dust showed, even to the naked eye, some brilliant points, indicating the presence of diamond crystals. After cleaning with acids the author once more examined the material under the microscope with 68 diameter magnification, and found that the original dull powder had been transformed into brilliant crystals, which, like natural diamond, burned in oxygen without leaving any residue.—*Cosmos.*

Cuttings from Scientific Papers.—Professional men who are in the habit of perusing technical literature every week find it to their advantage to keep some sort of record of the notes which they make in passing. There are various ways in which this may be done, but usually the simplest is to cut any paragraph of interest out of the paper in which it appears and file it in a card index or in some other similar manner. Some difficulty is apt to arise in this case through the fact that print appears on both sides of the paper, and occasionally two articles on different subjects are thus found on the same sheet. One way of avoiding this is to have the publications printed on one side of the paper only. It appears that this method has actually been adopted in a German periodical devoted to the physical chemistry of glass. The expedient seems thoroughly desirable from the point of view of the reader, but of course is open to the objection that it will just double the space occupied by a given amount of matter, and for this reason it is somewhat doubtful whether the system is likely to find extended application, although it seems likely enough that some very special publications may find it convenient to adopt.—*Umschau.*

TABLE OF CONTENTS

PAGE
Preserving Good Roads.—By Logan Waller Page.......... 21[illegible]
The Musical Memory and Its Derangements.......... 21[illegible]
Locomotive Number Fifty Thousand.—5 illustrations.......... 21[illegible]
Handwriting as a Clue to Mental Traits.—16 illustrations.......... 21[illegible]
Some Triumphs of Modern Surgery.......... 21[illegible]
Industrial Accidents and their Prevention.—7 illustrations.......... 21[illegible]
Aviation in the Sahara.—By M. P. James, C.E.—5 illustrations.......... 21[illegible]
Rules for Gould Aeroplane Prize.......... 21[illegible]
Pulleys and Belting.......... 21[illegible]
The Influence of Light on Vegetation.—By Dr. Alfred Gradenwitz.—4 illustrations.......... 2[illegible]
Pictorial Art Among the Bushmen.—4 illustrations.......... 22[illegible]
Antecedents of the Fireless Cooker.......... 2[illegible]
Losses of Combined Nitrogen.—By John D. Pennock.......... 22[illegible]
Trade Notes.......... 22[illegible]
Science Notes.......... 2[illegible]

arl, the
ustrian
can be
o cover
amonise
d, until
tion the
eek, the
. Then
d, with-
o days.
be very

lium the
s; white
5 parts;
are pul-
to the
ent. The
a second
ed with
nd again
leaf gold.
vith bril-
By this
compara-

een found
nds, such
action of
a portion
us powder
onds. Mr.
a view to
us formed
ven under
diameters,
was placed
o mercury
The ma-
ow current
At the end
ck carbon
st showed,
indicating
aning with
e material
gnification,
had been
ike natural
eaving any

sional men
l literature
p some sort
in passing
be done, but
of interest
file it in a
ner. Some
gh the fact
per, and oc-
ts are thus
iding this is
side of the
has actually
oted to the
seems ther
f the reader
it will jus
ount of mat
at doubtfu
nded applies
t some very
t to adopt.—

rs

PAGE
.... 21
.... 21
ions........ 21
strations... 21
.... 21
strations... 21
—5 illustra-
.... 21
.... 21
.... 21
Alfred Gra-
.... 22
s........ 22
.... 22
nock..... 22
.... 22
.... 22